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Government Price Control of Iron Now Terminated

For the First Time in More Than a Year an Open Market on Pig Iron Prevails, With a Proposed Reduction of $3.00 a Ton—War Contract Readjustments

GOVERNMENT control of iron and steel prices expired by limitation on Dec. 31 and for the first time in more than a year open market conditions will prevail. At its last meeting with the price-fixing committee of the war industries board, a special committee appointed by the American Iron and Steel institute recommended the adoption of a revised schedule of prices to apply during the first quarter of the year, but since the war industries board ceased to function after Dec. 31, official recognition was not given to this schedule. It involves a reduction of $3 a ton on bessemer, basic and foundry pig iron and $4 to $7 a ton on different steel products. Pig iron producers are not in accord on the action to be taken with reference to price readjustments. Some declare that former quotations barenetted them a profit and in preference to selling their output at $31 a ton they will blow out their stacks. Others, whose operations are on a more economical and profitable basis are inclined to meet this price on all business booked after Jan. 1, but they will not permit a revision in existing contracts for deliveries to be made in the first, second and third quarters of the year. These furnace operators declare that they still have a large tonnage of iron on their books at considerably less than government prices and since they are willing to make shipments on these contracts they can see no good reason why orders placed months ago at government prices should not be permitted to stand.

Most of the merchant furnaces have their output sold through the first half of the year and are making no effort to sell into the third quarter. Any considerable price reduction will be accompanied by the blowing-out of many furnaces and in view of the high existing costs of raw materials, labor and transportation, no material further concessions can be made without wiping out the profits of even the best equipped stacks. Although there has been considerable inquiry for pig iron for shipment to England and France, contracts have not been consummated and it is evident that foreign buyers are awaiting developments before closing definitely. England, France and Italy are short of iron. Since the beginning of the war, England has greatly increased her steelmaking capacity without a parallel increment in pig iron production. Therefore, both the English steel works and foundries will be compelled to depend upon the iron production of this country to a considerable extent.

The developments of the month indicate that our country was equally as unprepared for peace as it was for war. The conflicting suggestions and recommendations for accelerating readjustment made by the country's leading business representatives at the reconstruction convention of war service committees of the Chamber of Commerce of the United States held at Atlantic City, reflected no unanimity of opinion, other than perhaps that government price control be continued for periods varying from six months to two years. In view of the termination of the activities of the war industries board with the close of the year it was apparent to the members of the resolutions clearance committee that it would be fruitless to make any price control recommendation and the resolution finally adopted provided for the early ending of all government control of business.

For the purpose of adjusting the thousands of contracts for war materials that have been cancelled since the armistice was signed and to insure the early payment of claims, the war department has adopted a method of procedure that will expedite such settlements. The contractors have been requested to make inventories of the raw materials on hand, work in process and finished articles ready for delivery, with figures on the various elements of cost which have entered into preparations for production, such as new buildings, machinery, etc. These inventories will be checked by accountants of the war department and then will be presented to the district boards located in many of the larger cities, who will endeavor to make settlements with the contractors. If a settlement can be reached between the contractor and the board, a recommendation to that effect will be made to Washington and the amount involved will be paid promptly. Wherever a difference of opinion exists, a statement thereof may be made to one of the various boards of claims in Washington and an effort will be made to reach a settlement. Failing in this, the contractor may refer to his claim to a board of contract adjustment appointed to assist the secretary of war. This board is the final tribunal in such cases, but if the contractor is still dissatisfied with the decision, he may appeal to the board of claims.

How Gear Cases For Tractors Are Molded

Molding Machines of Large Capacity and Special Core Room Equipment is Employed — Special Rigging Effects Great Economies

FOUNDRYMEN everywhere are familiar with the manpower problem. Farmers this year are confronted not only by difficulty, but with a shortage of animal power as well. As a result, there has grown up a tremendous demand for practical farm tractors suitable for use in place of horses for plowing, cultivating, harrowing and other field work. This demand is being met by the leading manufacturers of agricultural implements, as well as by numerous other machinery builders, who have stepped into the breach with the result that more tractors driven by gasoline engines will be built in the United States this year than ever before.

The modern farm tractor, unlike its predecessor of several years ago, is a fairly light machine and, therefore, relatively inexpensive. It may be mounted either on a caterpillar gear similar to that utilized for tanks on the battlefield or on large wheels with steel tires. The machine also must be provided with a suitable motor, usually of the automobile type, together with transmission gears and steering mechanism, the whole being mounted on a frame of suitable design and construction.

The manufacture of these machines in large quantities involves heavy demands on the foundry industry, and within the past few months a number of important concerns have built large gray iron foundries exclusively for the production of tractor castings. These shops are called upon to turn out castings for cylinders, transmission housings, flywheels, pistons, large gears, etc. In many ways the work is similar to that handled in automobile foundries, with the exception that the parts are larger, more rugged and, therefore, heavier. From the foundryman's standpoint, one of the most interesting jobs involved in the manufacture of tractors is the transmission case. It usually is bolted to the frame of the machine immediately behind the engine and contains the speed change gears together with the worm or bevel gears which transmit the power to the axle shaft. The gears, of course, are much larger and heavier than those employed in automobiles and the case is correspondingly bigger. The successful production of these castings requires the solution of many interesting problems. An effort will be made in this article to describe the method of handling this job in the tractor foundry of the Moline Plow Co., Rock Island, Ill.

The transmission case for the Moline tractor consists of a bell-shaped casting with a heavy cylinder cast integrally on the small end of the bell. The axis of the cylinder runs at right angles to that of the bell. The complete casting weighs 250 pounds and is approximately 3 feet in length and 18 inches in diameter at the large end. The metal sections are comparatively light, ranging from ¼ to 5/16-inch. Several of the finished castings ready for shipment from the cleaning room are shown in Fig. 7.

The general method of molding is clearly indicated in Figs. 1 and 2. The pattern is split longitudinally, the casting being made in a two-part flask, 3 feet 6 inches long and 3 feet 3 inches wide. These are inside dimensions, the sides of the flask, which is cast iron, being 1 inch thick. The drag is 15 inches and the cope 13 inches in depth. The mold is made in green sand and the interior of the casting is formed by a large dry-sand core.

These castings are molded on a specially arranged floor equipped with two jolt-ramming, rollover molding machines of 1000 pounds lifting capacity, built by the Grimes Molding Machine Co., Detroit. Powerful machines are necessary on account of the size and weight of the flasks. One machine molds the copes and the other the drags.

A group of six men under the direction of a sub-foreman are employed on the job. Two men work on the cope machine and two on the drag, while the remaining two set the cores and close the molds. With the aid of the machines this gang turns out 30 finished molds a day in which nearly 9000 pounds of metal are poured. It is estimated that the same number of men doing the work by hand on the floor, without the machines, could not put up more than 10 molds in a day.

The floor on which this work is performed is 20 feet wide and 30 feet long. It is spanned by a 2-ton hand-operated traveling crane equipped with an air hoist. The latter is used for shifting the flasks and for transferring the finished molds from the machines to the floor. The hoist also is used for closing the molds and handling the large cores. In fact, very little work is done by hand.

Aluminum patterns are employed. They are firmly fixed to the pattern board on the machines in the customary manner. Fig. 2 shows the drag machine while the pattern is being drawn from the mold. As soon as the pattern is clear the mold truck is rolled out of the way and the rollover arm of the machine turned back to normal position for ramming the next mold. The general arrangement of the machine and its auxiliary equipment is clearly shown in Fig. 2. The sand is shoveled into the flasks and riddled by hand. The drag is given about 11 jolts, which is sufficient to ram it thoroughly.

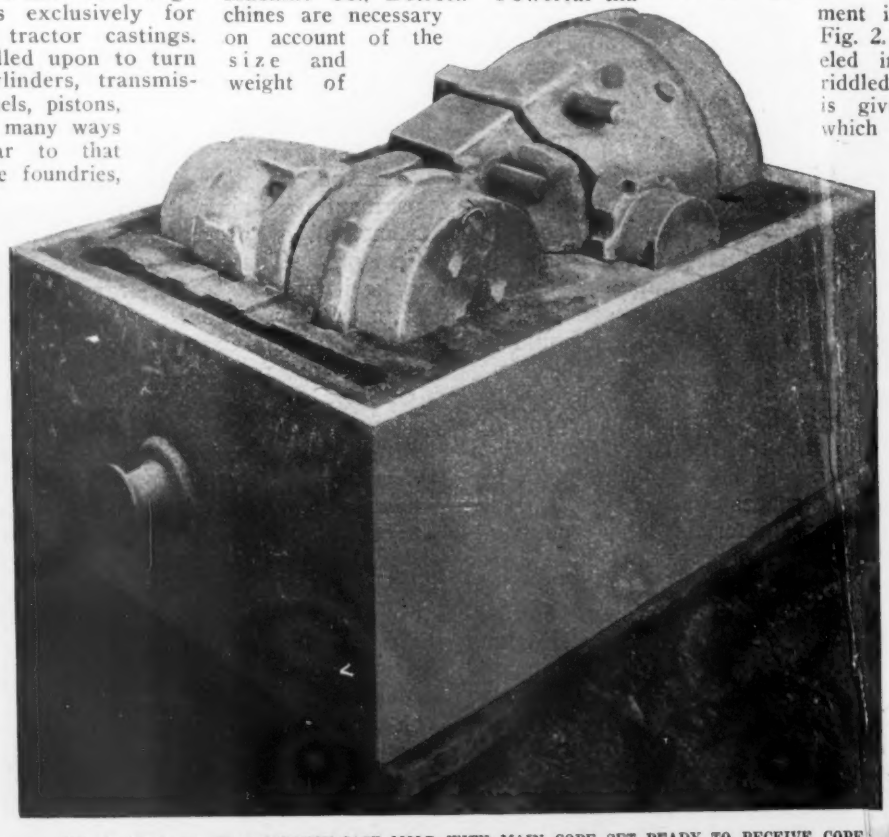


FIG. 1—TRACTOR TRANSMISSION-CASE MOLD WITH MAIN CORE SET READY TO RECEIVE COPE

Fig. 1 shows one of the drag molds on the floor with the large core set in place. It will be noted that wooden bottom boards are employed. This illustration clearly shows the method of gating. One runner extends from the pouring basin on the cope to the gate in the drag. The runner is in the corner of the cope and connects with the end of the gate. All of the metal enters the mold through this gate, three connecting sprues being provided. The cope mold is provided with h

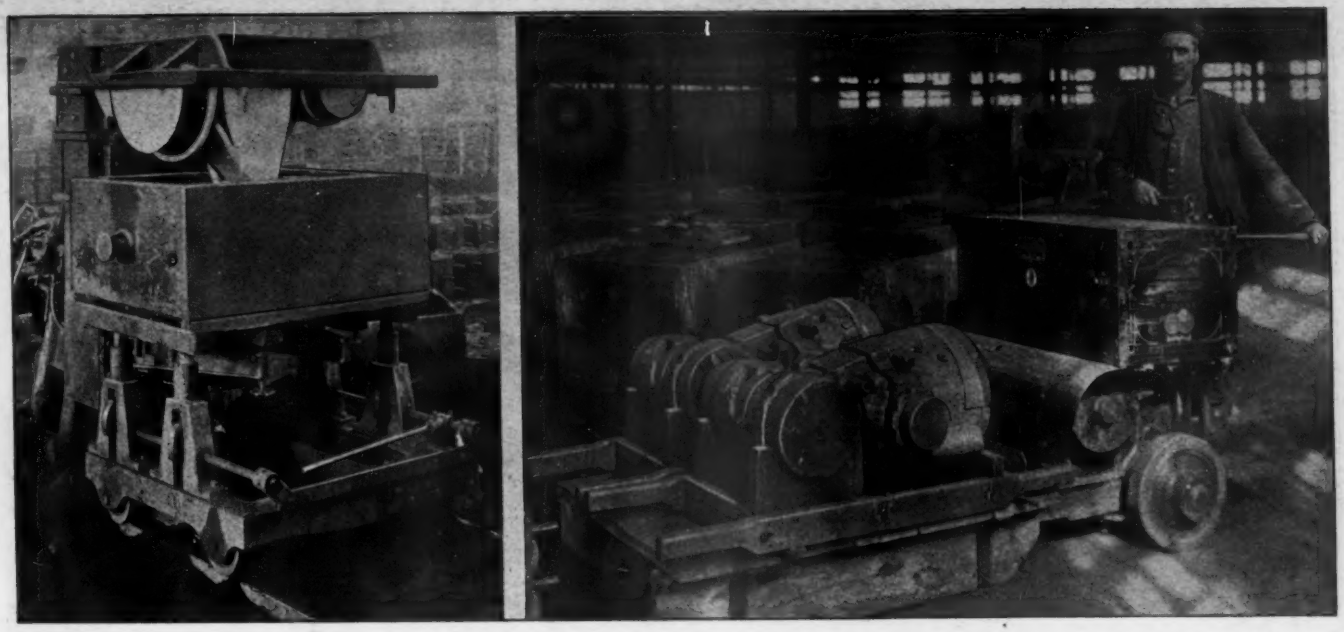


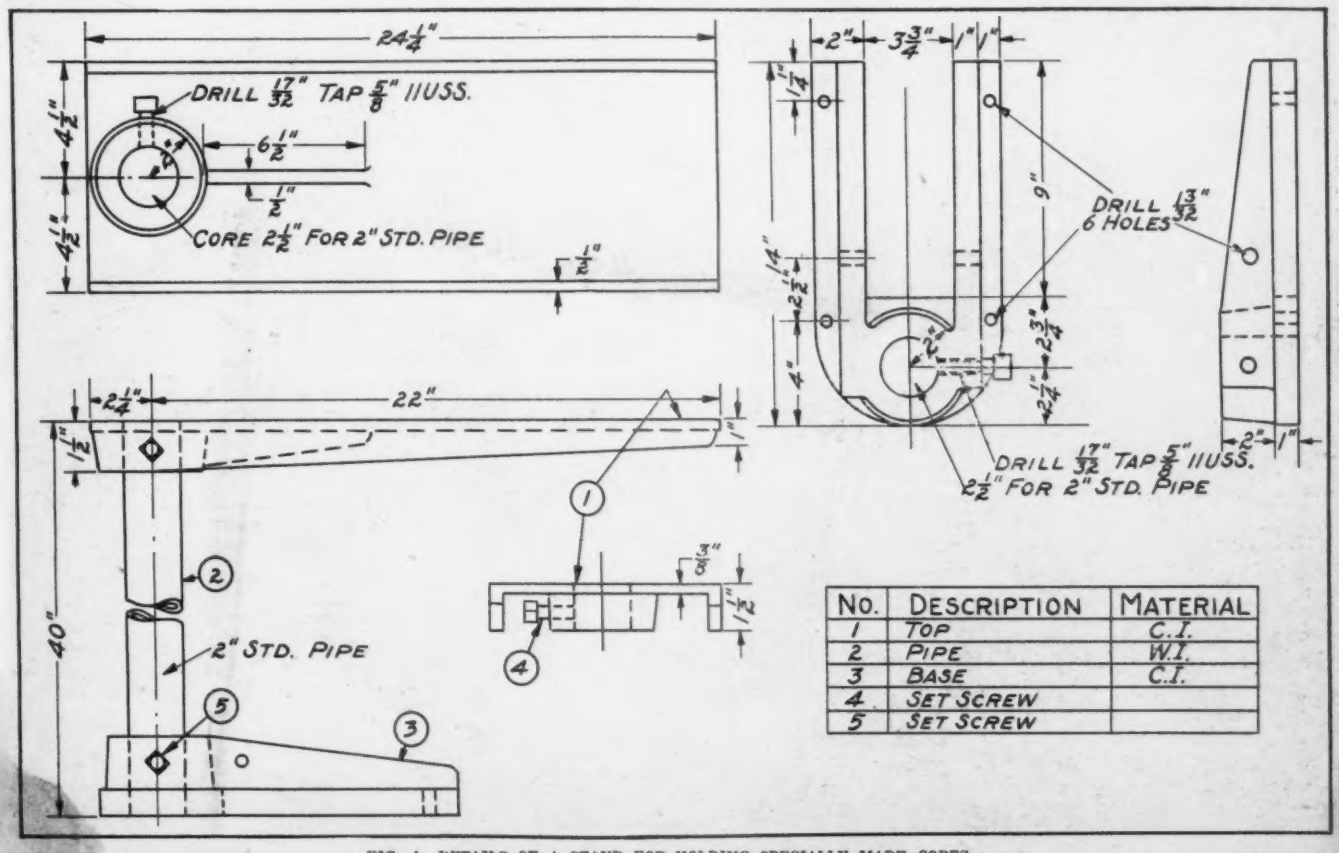
FIG. 2—DRAWING THE PATTERN FROM THE DRAG ON A JOLT-RAMMING, ROLLOVER MACHINE FIG. 3—THE LARGE CORES ARE TRANSFERRED FROM THE CORE ROOM TO THE MOLDING FLOOR BY STORAGE-BATTERY TRUCKS

bars which are tied together at four points by connecting ribs. These bars and ribs are cast integrally with the cope. The facing sand is first hand riddled into the cope, after which the necessary gaggers and the runner pin are set. Floor sand is then shoveled in until the cope is heaping full. On account of the necessity for holding comparatively large masses of sand in place, the cope is rammed harder than the drag, 20 bumps being given.

The cores form an exceedingly important part of this job. In addition to the large body core, shown in Fig. 1, there are two print cores in the drag and five in the cope. A heavy dry-sand support or print core shaped like a brakeshoe is set in the bell end of the drag to support the main core. This print core makes it certain that the main core is accurately lined up. In addition, the main core is supported by five chaplets set in the drag.

Fig. 5 shows how the main core is made. An aluminum core box is employed, the core being rolled out on a flat sheet-steel drying plate. The core box is rolled over by hand on the skids on which the finished core is slid along to the ovens. It will be noted that these skids are shod with light rails. The core box is set on the skids while it is being rammed-up. Two men are employed on the job. Care is taken to ram the sand lightly with the flat of a shovel. A monorail hoist is employed to transfer the cores from the delivery end of the skids to the oven cars.

The Moline Plow Co.'s foundry is



NO.	DESCRIPTION	MATERIAL
1	TOP	C.I.
2	PIPE	W.I.
3	BASE	C.I.
4	SET SCREW	
5	SET SCREW	

FIG. 4—DETAILS OF A STAND FOR HOLDING SPECIALLY MADE CORES

FIG. 5—SPECIAL EQUIPMENT IS PROVIDED FOR MAKING LARGE CORES. FIG. 6—THE CUPOLA EQUIPMENT IS UNUSUALLY COMPLETE

equipped with eight double-ended car-type core ovens, 8 feet wide and 12 feet long, together with six 6 x 8-foot single-ended car-type ovens, In addition, there is a battery of six continuous ovens in the girls' core room, where all of the small cores are made. All of these ovens burn illuminating gas, the flues being so arranged that one large burner serves three ovens.

The superintendent of the Moline Plow Co.'s foundry, Paul R. Ramp, believes in co-operation between the engineering department of the works and the foundry. He frequently calls on this department to prepare finished designs for foundry rigging of various sorts. A sample of the results of this co-operation is shown in Fig. 4, which illustrates a special core stand used in the girls' core room and elsewhere where small cores are made. This stand consists simply of a heavy cast iron base with a 2-inch pipe column carrying a rotating platform or table 2 feet long and 9 inches wide. This stand is used for holding freshly-made cores which have not yet been transferred to the oven racks. Since these stands are supported independently from the floor, the cores are protected from the damaging effects of the vibration resulting from the ramming operations on the work bench. This stand was designed by Mr. Ramp in co-operation with the Moline Plow Co., engineers and is constructed in the company's own shop.

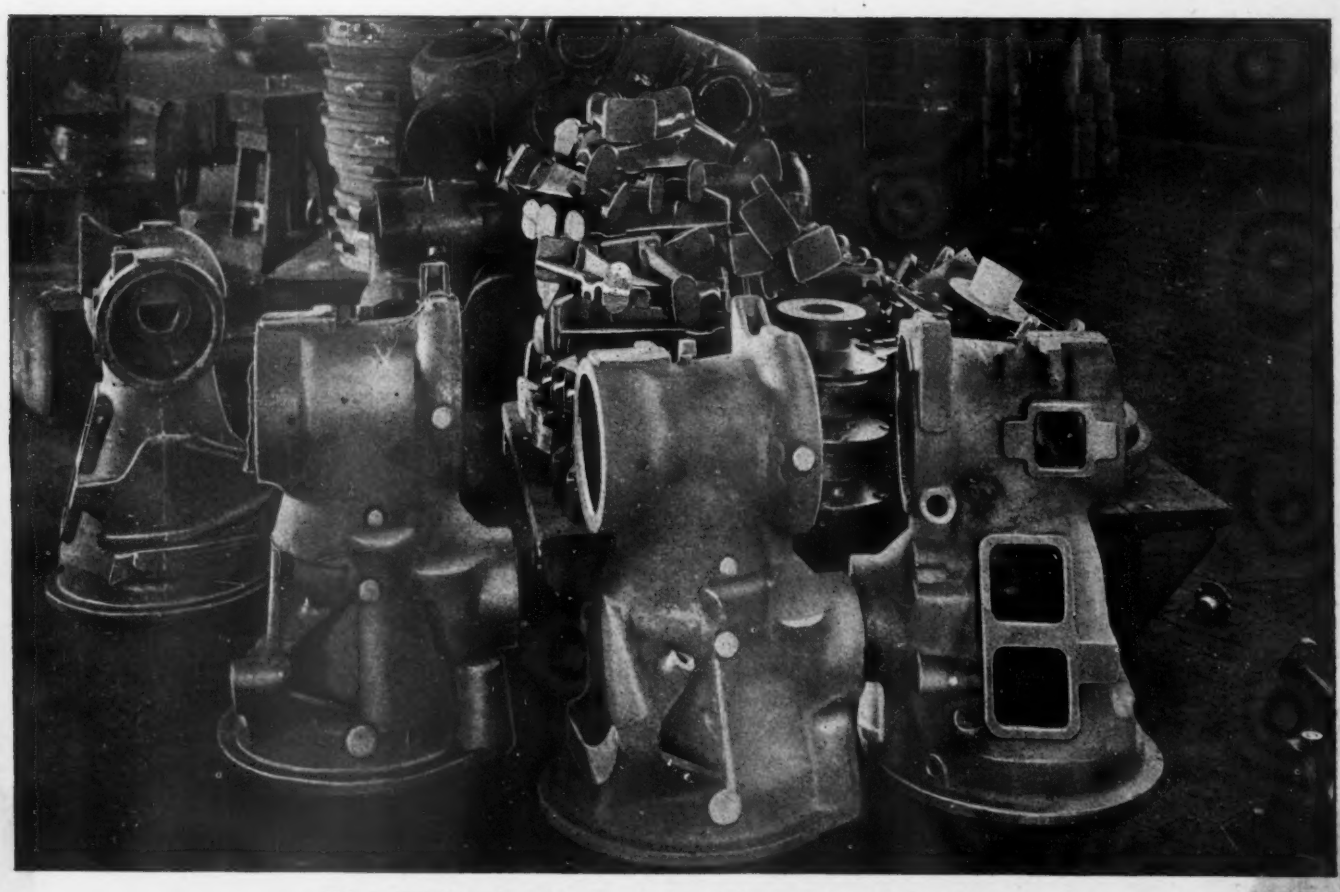


FIG. 7—THE TRANSMISSION- CASE CASTINGS ARE FINISHED BY SAND-BLASTING

A new design for tongs for removing hot core plates from the ovens is shown in Fig. 8. This design also was worked out by Mr. Ramp in co-operation with the company's engineers and the tongs are forged in the company's smith shop. They are 23 inches long from the center of the rivet to the end of the handles. The 3-inch jaws are hammered out to a flat 2¼ inches wide at the outer end. The holes for the rivet are drilled 33/64-inch in diameter. The handles are ⅜ by 7/16-inch at the outer end, this size having been found to conviently fit a man's hand and allow a strong grip to be had in handling the loaded plates.

After the large cores for the tractor transmission case are baked and pasted together they are transferred to the molding floor by the storage-battery lifting-truck shown in Fig. 3.

metal is drawn from the upper one. From 800 to 900 pounds of metal are tapped out at one time, the melting capacity of the cupolas being 100 tons per day. The metal is transferred to the floors for pouring in trolley ladles operating on an I-beam monorail system, as shown in Fig. 6. This illustration also shows the general arrangement of the cupola equipment including the double-ended tilting spout which makes it possible to spot one ladle while the other is being filled. The cupolas are equipped with standard auxiliary apparatus including a Clark blast meter. The Moline Plow Co.'s tractor foundry employs about 350 men in all of its various departments.

After the transmission case molds are poured and shaken-out, the rough castings are transferred to the cleaning room. After the cores are removed and the gates chipped off, the

blended with the desired amount of 200-mesh aluminum.

This mixture is next transferred to a crucible, which is lined with magnesia or alumina, and lighted with magnesium ribbon. After the reaction, when the slag has solidified, the metal is tapped and transferred to a standardizing furnace and the desired amount of metal of the chromium group is then dissolved in the molten alloy.

After standardization, the alloy is poured into molds made of carbon. The inventor states that the more desirable alloys comprise 1 to 10 per cent silicon, 1 to .12 per cent aluminum, 1 to 20 per cent zirconium, 1 to 25 per cent tungsten and the remainder nickel or cobalt.

To cut down manufacturing costs, the inventor states that it is desirable to make a composition showing a scleroscopic hardness of 80 or 90, but a composition of this hardness, it is said, does not possess sufficient

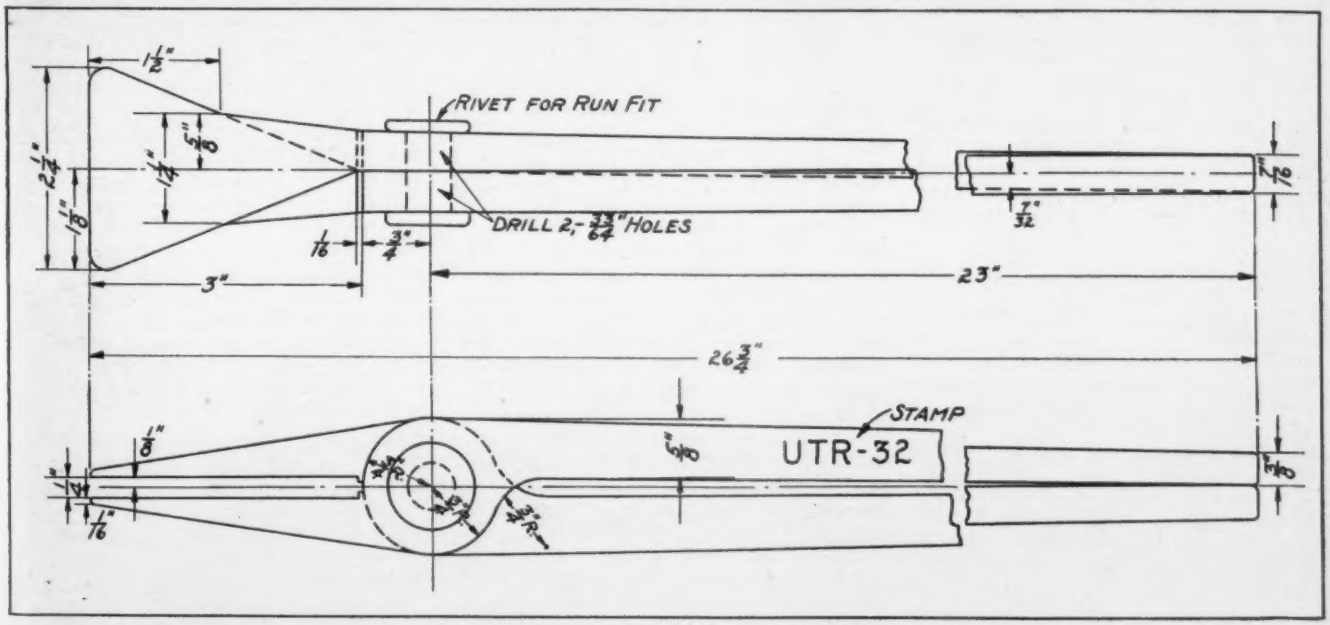


FIG. 8—DETAILS OF TONGS FOR REMOVING HOT CORE PLATES FROM OVEN

Each core is mounted on a specially made carrying frame which permits placing it conveniently alongside the molds. This carrier also supports the core at the proper points and prevents it from being damaged while it is in transit.

Three cupolas are provided for melting the metal at the Moline Plow Co.'s foundry. Two are 66 inches in diameter inside of lining with a capacity of 15 tons per hour; one is 57 inches in diameter with a melting capacity of 12 tons per hour. The two 66-inch cupolas were furnished by the Whiting Foundry Equipment Co., Harvey, Ill.; the 57-inch cupola is of the Colliau type now marketed by the Central Foundry Supply Co., Columbus, O. The 66-inch cupolas are charged with 6600-pound bed charges of coke followed by regular charges consisting of 2000 pounds of iron and 200 pounds of coke. These cupolas have two tap holes in the breast one above the other. Ordinarily the lower tap hole is used, but if it freezes during a long heat, the

castings are thoroughly sand-blasted. They then undergo a final inspection after which they are shipped to the machine shop for the fine machining before going to the assembly floors for erection.

A New Alloy for Cutting Tools

An alloy for use in cutting tools which is said to have efficient cutting properties has been patented by Hugh S. Cooper, Cleveland. The alloy comprises nickel or cobalt, zirconium, aluminum and silicon, or their equivalents, together with one or more metals of the chromium group, for example, tungsten, molybdenum, chromium or uranium. According to the inventor, the introduction of one or more of the metals of the chromium group improves the cutting efficiency of the alloy.

In producing this material, the desired portion of nickel oxide black and Brazilian zirkite, carrying a minimum of approximately 90 per cent zirconium oxide and about 15 per cent silica, is ground to 200 mesh, sifted, dried and thoroughly

strength to be most efficien. for cutting tools. It is said that our alloy showing a hardness of 58 to 65 will cut almost any metal encountered in ordinary shop practice. For this reason, more nickel is added to a given composition which is harder than 58 to 65, thus increasing the strength and toughness of the composition.

A given composition of nickel, aluminum, silicon and zirconium having an excess hardness may be improved by adding 4 per cent more nickel. It is also said that by increasing the amount of tungsten the amount of nickel may be reduced to less than 24 per cent.

The following changes have been made in the personnel of the Brown Hoisting Machinery Co., Cleveland: Harvey H. Brown has been elected chairman of the board of directors; Alexander C. Brown, president, and Melvin Pattison, vice president and general manager. E. C. Pierce has been appointed general manager of sales, and Robert G. Clapp and John F. Price have been added to the board of directors.

Wartime Experience With Women Metal Workers

Their Efficiency Has Been Demonstrated in Core Shops, Foundries and Metal-working Plants Generally and in Some Respects They Are Superior to Men

DISTINCTLY favorable results from the wartime employment of women in metal trades are shown in a report by the National Industrial Conference board. The report summarizes information obtained from 131 establishments employing 335,015 men and 49,823 women, and treats of the comparative wages and output of men and women, the hours of work, and numerous other matters of general interest and of practical value to employers contemplating the introduction of female labor.

The report discusses the problem from the standpoint of factory experience; the broad question as to whether the employment of women in the metal trades is desirable on social grounds is not taken up.

The investigation showed that no extensive substitution of women workers for men had as yet taken place in these trades. In 95 establishments reporting on this specific point, only 10,657 women were employed on work formerly performed exclusively by men, and approximately half of this number were in only 10 munitions establishments.

The work done by women in the metal trades embraces a great variety of processes from the operation of ordinary drill presses and lathes to coremaking, inspecting and assembling mechanical parts, and many precise machine operations. In the main, however, their work has been confined to the lighter processes in which rapidity and dexterity are more important than technical skill acquired by long training. The report emphasizes that work of a repetitive character is exceptionally well adapted to the utilization of female labor.

Output of Men and Women Compared

Comparing the output of men and women, the report shows that in 64 establishments of the 97 furnishing specific information on this point and where men and women were employed on the same processes, the output of women was equal to, and frequently greater than, that of men. In only 15 establishments was the output of women less than that of men on all operations on which both were employed. In the remaining 18 their production, although less in some operations, equaled or exceeded that of men in others.

A highly favorable account of the efficiency of women comes from an automobile plant where they were employed in 23 departments on assembling and inspecting materials and on many types of machine work. In this case the comparative output of women on identical processes was almost invariably greater than that of men and in some cases quite disproportionately so. This establishment reported an instance where a woman employed on a nut tapping machine turned out at the end of her first week about double the output of the man working next to her. "After endeavoring to equal her speed for a few days," the report continued, "the man quit and was replaced by another woman who is now very nearly the equal of the first."

Women Increase Output

A gear-manufacturing establishment where women do sandblasting, grinding, drilling, and broaching gives their output as from 15 to 25 per cent higher than that of the men.

In a munition plant manufacturing fuses, women operatives on drill presses and milling machines were found to be from 25 to 50 per cent more rapid than men. A manufacturer of small metal parts for munitions states that women drill press operators finish 196 parts an hour on day work, while men on the night shift finish only 146 an hour. Although day and night work are not exactly comparable, the output difference is enough to indicate the superiority of the women in this case.

Employers generally commended women as being more thorough and conscientious, as producing less spoiled work, and as being more careful with tools. Even where the quantity of work produced is less than that of men, the quality is frequently better. Women were also reported as more regular in production, and did not show the tendency to restrict output which is sometimes characteristic of men.

Whether technical training would make women the equal of men in work of higher character cannot be determined from available experience. At present their lack of training automatically excludes them from highly skilled work.

It is noted, however, that there are certain operations which no employer reports as being performed as well by women as by men; for instance, lapping and brazing, both of which require considerable skill. Again, women have not proved themselves the equal of men in such comparatively heavy work as chipping castings and machine filing. Most manufacturers agree that women should not be employed on heavy work or in processes exposing them to gases, fumes, or unusually high temperatures.

General acceptance by employers of the principle of equal pay for equal work is indicated by the report. A comparison of women's wages with those of men engaged establishments making complete statements on output and wages shows that in 56, women receive equal pay, and in 28 equal piece rates but lower time rates. In only 28 establishments, or 22 per cent of the total, are women paid a lower scale than men for both piecework and timework. In these cases the difference ranges from 10 to 20 per cent, although in isolated instances it was 30 per cent or even more.

Among reasons assigned for a lower wage scale for women were their lower efficiency while learning and the additional expense required for special equipment and more supervision, or their need for skilled assistance, such as in setting-up machines, or for help in heavy lifting. At times, however, it appeared that lower wage rates had been based on only slight differences in the character of the work.

Work-hours of women are largely dependent on the labor laws of the respective states. Nevertheless in 56 establishments of 105 reporting, women were working fewer hours than the legal limit. In most states represented in the investigation the legal maximum is 54 hours per week. In Ohio, however, it is 50 hours and in California 48.

Only 20 establishments had maintained stated rest periods; these, however, employed 18,546 women workers. The periods vary in length from five to 15 minutes, a freqeunt arrangement being a 10-minute rest in the middle of the morning and 10 minutes more in the afternoon.

Although experience with rest periods as embraced in the board's report is thus limited, the results were distinctly satisfactory. The report points out furthermore that extensive experience, notably in British munition factories, indicates definitely that such rest periods are advantageous to employers as well as to employes, and demonstrates the wisdom of their more general adoption.

Training of Women Workers

Successful utilization of women depends very largely on the methods of selection and training as well as on the adaptation of plant organization and equipment.

Of the three methods of training ordinarily resorted to, namely, by trade schools, by foremen, or by special factory training departments, the latter is undoubtedly the most effective.

Twelve establishments covered by the investigation had installed special training departments, in which small groups of new female employes are instructed under actual factory conditions in a room separate from the rest of the plant. The training of

each individual is directed toward the acquisition of high efficiency in a specific operation. After the operation has been explained and illustrated, each individual is allowed to start actual productive work under careful supervision. The use of precision tools and the reading of blueprints is usually made part of such a course, which may cover from three days to two weeks, according to the character of the work involved and the ability of the worker. In some cases several factories have combined to maintain training facilities of this type.

Trained on the Job

Comparatively few establishments recruit workers from local industrial schools. The majority train the women directly in the factory, and there the active co-operation of competent foremen is of primary importance.

There are some serious disadvantages in this method. One manufacturer reported: "Our experience is that the old-line foremen are prejudiced against the employment of women, and will be antagonistic in their attitude, will prejudge the possibilities adversely, and under these conditions their employment will be doomed to failure. Supervision by a broadminded person convinced of the possibility of using women advantageously, and competent to adapt and alter the method of work, is essential." This type of supervision is conspicuous in plants where the best results have been secured.

It was the general experience that women are "more teachable," "quick to learn," and that they "follow instructions better" than men. In fact, in 103 establishments reporting, the attitude of women toward their work was considered to be as good or better than that of the men; in only eight was it regarded as worse.

One reason given for this was that the women are superior to the class of men at present available. Some employers reported that the increased demand for the services of women is tending to make them more independent than formerly, although one machine tool manufacturer with wide experience stated that women are "as exacting as men, but no more." Women are generally reported as taking a more personal attitude toward their work which is reflected on the one hand in greater sensitiveness to criticism and on the other in increased loyalty.

In 84 of 115 establishments reporting on this point the attendance of women employes was stated as equal to or better than that of men. In 31 it was worse; these 31, however, included 18,037 women employes, or 47 per cent of the total number of women in the establishments reporting attendance. Experience in other countries, notably in Great Britain and in France during wartime, indicates quite definitely a poorer standard of attendance among women than among men. Contrary to rather generally expressed opinion, it appears that the atendance of married women was fully equal to that of younger unmarried girls.

Greater stability of female labor was generally indicated by the information gathered in the course of the investigation. Of 94 employers reporting on this subject, 60 stated that the record of the women was better than that of the men; 26 that there was no difference; only eight that the turnover among women employes was higher. In this respect, therefore, the results are exceptionally favorable to employment of women.

The most frequent factory change necessitated by the introduction of women workers is the employment of additional supervisors and of helpers for heavy lifting. Although the need for such supervision and assistance deters some manufacturers from employing women, many experts in scientific management contend that, even if male workers only are employed, such intensive supervision is a most effective means of increasing production.

Several large employers place their women employes in separate departments or factories. Others with equal success employ them side by side with men. Where women workers were taken on for the first time, improvements were almost invariably made in factory surroundings, such as safeguarding machinery, provision of hospital facilities, lunch rooms and rest rooms. It was, furthermore, the general concensus of opinion that the expenditure for such improved accommodations had been fully justified by the results.

In conclusion the report states that the experience assembled in the course of this study shows clearly that the employment of women in machine shop work in the metal trades is practicable. The increasing scarcity of men and the certainty that more would be withdrawn from industry for military service made the more extensive employment of women almost inevitable, while the demands of war production were urgent.

No Lack of Women Workers

Thus far manufacturers have found no lack of women applicants for positions. Most of their workers are drawn from other industries, or from department stores, offices, restaurants, laundries, and domestic service. In many cases the wives and dependents of men in military service, and friends and relatives of former employes, have been given preference. The employment of women not previously wage-earners is as yet the exception, but employers are now beginning to draw upon this class.

The permanence of women's position in the metal trades will, the report holds, depend in part on the attitude and economic strength of male workers after the war. Surprisingly little opposition to the introduction of women has thus far been encountered from men, possibly because of the relatively small number of women thus far employed or because the urgency of the step was recognized. Yet one employer expresses the view that "when jobs are not so easy to get it will be different." Others, however, were of the opinion that women would continue as a permanent factor in the metal trades, especially on the lighter kinds of work.

Whatever the ultimate experience may be, the ability of women to perform a large variety of operations in metal trades has been demonstrated.

A Unique Sand Plant

By C. C. Johnston

At New Lexington, O., in the famous Hocking valley, the Perry Coal & Sand Co., with headquarters at Columbus, O., operates a mining plant that is decidedly unique. Both coal and sand are taken from the one property which consists of 150 acres. The surface strata is high grade molding sand and has an average depth of about 9 feet. It is deposited on a bed of shale about 5 feet in thickness and underneath this is a seam of excellent coal, averaging from 4 to 5 feet. The property has been under development for about a year and large shipments of sand already have been made to foundries throughout the country. A considerable tonnage of coal also has been mined. As the shale strata is uncovered by the removal of the sand, steam shovels will be utilized to strip the shale, thereby exposing the seam of coal which will be mined in the open. In comparatively few localities is the coal seam sufficiently near the surface to permit of stripping. The sand is mined by steam shovel and is conveyed by mine cars to a stockhouse from which it is loaded into cars by a belt conveyor. A force of nine men can load 400 tons of sand a day. W. E. Wheeler is president of the Perry Coal & Sand Co., and J. E. Mason, vice president.

Assumed Shrinkage on Metal

By Dr. Robert Grimshaw

Many foundrymen, instead of weighing up the charge, dump and castings, including gates, etc., to get the actual shrinkage, assume it to be many per cent, this assumption not being based either on their own or on any one else's actual experience. Some, "in order to be safe," assume that for every gross ton charged, they will tap a net ton. But that is far from being safe in the proper sense of the term. It means a loss of 3/28 of the metal or about 3.571 per cent; in other words, that metal which costs $44.80 a gross ton on the charging floor, or 2 cents a pound, really costs $44.80 x 1.12 or $50.17; that is, 2.124 cents a pound for the metal at the tap hole.

Using this percentage for getting the price for the metal in the castings, instead of say 4 per cent, which would make the cost for metal only $46.59 per gross ton (2.0714 cents a pound) might bring the estimate on a good-sized job just $0.00025 a pound for castings above the price quoted by a rival whose melting loss was 4 per cent and who knew it, because he used scales instead of thumb-rule.

Organizing a Foundry to Obtain Top Production

A Systematic Method of Following Up the Work of the Foreman of Each Department is Essential to a Successful Organization

By Paul R Ramp

IN organizing a foundry to produce tractor castings, the question of suitable buildings and proper shop equipment must receive careful consideration. Equipment can be furnished today to take care of almost every operation in the foundry, and manufacturers are in position to exhibit the results of their labors along this line in numerous foundries throughout the country. This fact is of great help in deciding what tools will best suit individual needs; and foundrymen are relieved to a great extent of the equipment problem by relying upon manufacturers who have made this part of the business their life study.

The same is true regarding the buildings. Construction engineers are able to design buildings to handle particular work to the best advantage. This saves the large amount of work and study necessary to design the buildings, and at the same time provides a much better layout by men trained for this branch of work.

This was not true years ago—then the foundryman was expected to divide his time between designing a foundry, inventing equipment and managing operations. The writer's father, also his grandfather both worked harder to produce a smaller tonnage, because of this condition in their day.

Many firms spend large sums on new buildings and new equipment and wonder why they do not get the best results. The answer is "lack of organization." They must remember that the old organization does not fit into the new conditions.

It is a sad sight to see the old gang in the new shop doing things just as they did 40 years ago, and just like they did in the old shop. They appear to think the new shop and the new equipment is all that is necessary. But modern apparatus has no value unless it is put to work.

With modern foundry buildings, good crane service, modern equipment for molding, coremaking and casting cleaning departments, good melting facilities, and a layout that will reduce the general labor to a minimum, a decided reduction in the cost of producing castings can be made, and at the same time quality will be improved.

There are many foundries of this kind in operation today, and if a careful analysis be made of what really caused the reduction in the cost of production in many cases it would be found that the increase in tonnage alone was responsible. Any kind of foundry practice will produce 100 tons of castings cheaper than 40 tons per day, for the reason that the overhead expenses are reduced. The nonproductive labor is less per ton and the material can be purchased at a more reasonable rate.

Now if the most modern foundry practice be established in a modern foundry upon the day the first metal comes from the cupola, a different result will be obtained, and the reduction in the cost of castings resulting from the increased tonnage will be only a small percentage of the saving. The time to make a new foundry pay is the first day castings are made in it. That is the time the foundry superintendent should lay aside the hat his father wore, get out of the old rut and insist upon his men working according to modern methods. A molder cannot produce any more molds because he is working in a new shop, if he has the same old flask, or the same old pattern he had in the old shop, and is molding it the same old way. Even if he can, it would be a hard matter to make him do it.

When the New Broom Sweeps

But if this old job is carefully analyzed with a view to molding it the cheapest and safest way, and alterations made to flasks and patterns accordingly, a gratifying increase in production can be realized, and the fact that everyone expects changes in the new shop will help to establish the daily production on the job without the usual opposition.

Every job that is started in the new shop should be handled in this manner without too much consideration as to how many there are to make. At this time profit realized is not so much the question as is the problem of establishing a modern foundry practice that will result in a reduction in the cost of productive labor. With the increase in the production per molder, the nonproductive labor will drop automatically. It is just as important to devise a system of supervision that puts to work, and keeps to work, every part of a plant, as it is to build and equip the shop.

The secret of successful organization lies in getting the right men on the jobs they can do the best, and keeping them busy.

A foundry organization should consist of a foundry superintendent in general charge, a foundry foreman in charge of molders, a core room foreman in charge of coremaking, a casting foreman in charge of the casting cleaning room, and a general labor foreman in charge of all unskilled labor. A patternmaker foreman in charge of patternmakers and pattern storage, a production clerk, a cost clerk and a timekeeper also are essential.

The size of the shop will determine whether or not a man will be required to devote all of his time to one or more branches of the work handled.

In order to create and maintain this organization and get results, the foundry superintendent must systematize his work in a manner that will keep him in close touch with the success and the failures of every department and every man in the plant.

We have proved to our entire satisfaction that with the proper information at hand daily, the foundry superintendent or manager can in less than 30 minutes know how efficient is every branch of his organization and where he is most needed. First, he must have a daily labor distribution sheet similar to that shown in Fig. 1. This sheet must be posted early every morning ready for him to look over after his first trip around the shop.

This report should show the money cost of the following operations or departments during the day previous: Patternmaking, hand molding machine molding, molders' helpers, coremaking, coremakers' helpers, cupola labor, cleaning castings, general labor, total melt, good castings per floor, and any other important items. The weight of the "good castings per floor" should be entered not later than the second day after the heat.

This report gives him what the monthly or weekly cost report fails to do, a chance to get quick action on expensive errors, or leaks before a heavy expense is incurred.

It is not necessary to go into detail regarding the value of this sheet, further than to say the wide awake foundry manager will quickly detect a variation in the cost of any department with this sheet before him. He will at once find out the reasons for this variation, and take the necessary steps to cure the evil. He will want to know why his coremaking cost is $30 more yesterday than for the day before; why the general labor has gone up $5 and why the weight per floor has dropped. The fact that he is following these things daily, rather than weekly puts every foreman he has on his mettle, and keeps him working on the job every moment.

A daily production sheet similar to the one shown in Fig. 2, keeps him informed of any delays or any work that is not started according to schedule. The plan is to look over the production sheets for the work not being done rather than for the work that has been accomplished.

As it is a quick job to locate the slow moving parts, or parts that have not been started, on this sheet, it requires only a few moments to look over the entire list of orders for a large shop, and thus the superintendent has the information that enables him to get behind the slackers before there is any outside complaint.

With orders lined up in this manner, the coreroom clerk must keep a similar sheet in the coreroom cover-

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From a paper presented at the 1918 meeting of the American Foundrymen's association at Milwaukee. The author, Paul R. Ramp, is superintendent, Campbell, Wyant & Cannon Foundry Co., Muskegon, Mich.

DAILY FOUNDRY DEFECTIVE WORK

_____ DEPT. DATE _____

PATT. NO.	DEFECTIVE BUT NOT REJECTED	REJECTED	WEIGHT REJECTED	NATURE OF DEFECT	WORKMAN'S NAME	WORKMAN'S EXCUSE	FORMAN'S REPORT	FOREMAN'S REMEDY

_____ INSPECTOR _____ FOREMAN

FIG. 1—DAILY LABOR DISTRIBUTION RECORD TO BE PLACED IN THE HANDS OF THE SUPERINTENDENT EVERY MORNING

DAILY PRODUCTION RECORD

MAY SCHEDULE

DESCRIPTION	TRANSMISSION CASE	CYLINDER	CYLINDER HEAD	BOTTOM CRANK CASE	GEAR CASE COVER	PISTON	CYLINDER HEAD COVER	FAN BRACKET	FLY WHEEL	TURNING GEAR	VALVE STEM GUIDES	INTAKE MANIFOLD	EXHAUST MANIFOLD	MUFFLER END FRONT	MUFFLER END REAR	GOVERNOR HOUSING	CAM SHAFT TURNING GEAR	MAGNETO BRACKET	FAN BELT PULLEY	POWER BELT PULLEY	STEERING SEGMENT	HOUSING END PIN	HAND HOLE COVER
ORDER NO.	1440	1440	1440	1440	1440	1440	1440	1440	1440	1440	1440	1440	1440	1440	1440	1440	1440	1440	1420	1420	1430	1430	1440
PATTERN NO.	5004	5000	5032	5121	5122	5003	5005	5123	5124	5125	5126	5127	5128	5129	5130	5131	5132	5133	5134	5135	5136	5137	5138
CORE NO.																							
REQUIRED DAILY	50	50	50	50	50	200	50	50	50	50	200	50	50	50	50	50	50	50	50	50	50	50	50
TOTAL WANTED	1250	1250	1250	1250	1250	5000	1250	1250	1250	1250	5000	1250	1250	1250	1250	1250	1250	1250	1250	1250	1250	1250	1250
DATE	Day Mon.																						
MAY 1	50 50	50 50	60 60	50 50	40 40	100 100			50 50	100 100	800 800	50 50	70 70	100 100	600		60 60		400 400	50 50			
" 3	50 100	40 90	60 120	50 100	40 80	100 200			50 100	200 300	600	50 100	70 140	100 200			60 120		400 800	50 100			
" 4	50 150	45 135	60 180	50 150	40 120	150 350			50 150	300 600	800	50 150	70 210	100 300			60 180		400 1200	50 150			
" 5	50 200	50 185	60 240	50 200	40 160	150 500			50 200	400 1000	800	50 200	70 280	100 400			60 240		400 1600	50 200			
" 6	55 255	50 235	70 310	50 250	40 200	200 700			50 250	500 1500	1000		70 350	100 500			60 300			50 250			
" 7	50 305	45 280		50 300	40 240	200 900			50 300	600 2100	800	50 250	70 420	100 600			60 360			50 300			
" 8	45 350				40 280	200 1100	50 50		50 350	700 2800	600	60 310	70 490	Man Off			60 420			50 350			
" 10	45 395		65 375		50 330	200 1300	50 100		50 400	800		60 370	70 560	Man Off	100 100	100 100	0 420			50 400			
" 11	50 445		70 445		40 360	200 1500	50 150		50 450	800		60 430	50 610	Man Off	100 200	100 200	0 420			50 450			
" 12	50 495		75 520		40 400	250 1750	50 200		50 500	800		60 490	70 680	Man Off	100 300	60 480				50 500			
" 13	55 550		73 593			250 2000	50 250	200 200	50 550	800		60 550	70 750	100 700	100 400	60 540				50 550			
" 14	50 600		75 668			250 2250	50 300	200 400	50 600	800		60 610	70 820	100 800	100 500	60 600				50 600			
" 15	50 650		74 742			250 2500	50 350	200 600	50 650	800		60 670	70 890	100 900	100 600	60 660	200 200			50 650			
" 17	55 705		75 817			300 2800	75 425	200 800	50 700			60 730	70 960	100 1000	100 700	70 730	200 400			50 700			
" 18	50 755		30 847			300 3100	75 500	200 1000	50 750			60 790	96 Days	100 1100	100 800	70 800	200 600			50 750			
" 19	50 805		70 917			300 3400	75 575	200 1200	50 800			60 850	70 1030	100 1200	100 900	70 870	200 800			50 800			
" 20	50 855		70 987			300 3700	75 650	200 1400	50 850			60 910	70 1100		100 1000	70 940	200 1000			50 850			
" 21	50 905		75 1062				75 725		50 900			60 970	70 1170		100 1100	60 1000	200 1200			50 900			
" 22	45 950		70 1132				75 800		50 900			60 1030	70 1240		100 1200	50 1050	200 1400			50 950			
" 24	50 1000		40 1172				100 900		50 1000			60 1090	70 1310		100 1300	50 1100	400 1800			50 1000			
" 25	50 1050		70 1242				100 1000		50 1050			60 1150				50 1150	400 2200			50 1050			
" 26	50 1100		70 1312				100 1100		50 1100			60 1190					400 2600			50 1100			
" 27	50 1150						100 1200		50 1150			60 1250								50 1150			
" 28	50 1200						100 1300		50 1200			60 1310								50 1200			
" 29	50 1250								50 1250											50 1250			
" 31																							

FIG. 2—DAILY PRODUCTION RECORD TO BE MADE OUT IN DETAIL AND HANDED TO THE SUPERINTENDENT EVERY MORNING

DAILY LABOR DISTRIBUTION

MONTH OF

DATE	PATTERN MAKING	HAND MOLDING	MACHINE MOLDING	MOLDERS HELPERS	CORE MAKING	COREMAKER HELPERS	CUPOLA LABOR	CLEANING CASTINGS	GENERAL LABOR		TOTAL MELT	GOOD CASTING	

FIG. 3—DAILY FOUNDRY DEFECTIVE WORK REPORT TO BE MADE OUT BY THE FOREMEN AND HANDED TO THE SUPERINTENDENT

ing all parts that require cores with a separate column for each core required to make a complete set, and each set of cores in groups. The foundry superintendent must look over this coreroom sheet while on his first trip around the shop in the morning, as it is possible to have the core production posted earlier than the general production sheet.

The same plan is carried out in the casting cleaning room. This sheet is the same as the general production sheet only showing the delivery of castings instead of molding. The superintendent also should look over the casting cleaning room sheet on his first trip around the shop. After he has returned to the foundry office and checked up the general production sheet, he is well informed as to how the work is moving in every department.

This plan does not make a production clerk out of the foundry superintendent as some may think. The writer has gone over the daily labor sheet, the daily production sheets and the defective records in less than half an hour and secured the information necessary from each one that enabled him to bolster up the weak places in his organization.

Every foundry has a bad casting report, as this report is absolutely necessary to the cost department. Now in organizing a foundry that is going to produce tractor castings or any other standard castings at a reasonable cost, and of a quality superior to the castings made by the majority of foundries, it is advisable to have in addition to the regular bad casting report, a daily foundry defective work record, as shown in Fig. 3.

This report not only gives the number of bad castings, but the number of castings defective but not lost. It is just as important to reduce the number of castings made that are not perfect but can be used, as it is to cut down the percentage of defective castings that must be scrapped. With this in mind we insist upon a daily record under the heading "defective but not rejected," in addition to the regular bad work report. The manner in which the daily defective work report is handled is as follows:

The casting inspector or cleaning-room foreman furnishes each foreman who is directly in charge of a number of molders or coremakers a report on this blank daily. This report covers all the lost or defective castings or cores made by the men under the foreman.

How Report Is Filled Out

The report the foreman receives will be filled out under the following headings: pattern number; defective but not lost; number rejected; weight of rejected; nature of defect. The blank space under the headings should contain space for: workman's name, workman's excuse, foreman's report, foreman's remedy.

Upon receipt of this report it is the foreman's duty to immediately investigate each case reported. He must fill in the name of the workman who made the bad work. The record of the man's excuse, his report as to what he thinks is the cause of the defect and his remedy. This remedy will be what he thinks should be done to overcome the trouble. When this report is completed, the foreman must deliver to his superintendent or to the trouble man, if the latter is a part of the organization.

Some will say, "This is a lot of red tape. You are loading up the foreman with work that should be performed by a clerk." This is a mistake. The clerical part of the job can be done easily as the foreman investigates each case.

This report is not made as a record for accounting, but is an instrument to place in the hands of the foundry superintendent to use to get prompt action out of his foremen on all defective work. Should a foreman complain that he is too busy to do this work, he is not big enough for the job. If one foreman has so many men directly under him that he is unable to spare the time to investigate the cause of their losses, and teach them how to overcome their trouble, we can feel safe in deciding we have a weak spot in our organization that should be strengthened at once.

The report system also informs the foundry superintendent how a foreman is handling his men. It is surprising how many foremen there are who trust to luck and their men and get away with it. It is also surprising and gratifying to know how much more a good man can do toward making better castings and cheaper castings if he works at the job systematically.

We have found that it is more important to try and induce the foreman to work at his part of the job steadily than the men under him, as the latter will get in line if the foreman is on the job. And this defective work record was designed simply to make the foreman do the things he should do in order to give his employer the best there is in him.

In order to secure the workmen's excuse, he must visit him and talk to him about the bad work. At this time he will naturally tell him how to avoid the loss in the future, and why his excuse is not legitimate. In order to give the foundry superintendent an intelligent report on what he believes to be the real cause of the defect or loss (under the head of foreman's report) he must inspect the casting. This gets him out where we want him every morning—to the scrap pile. The fact that he is obliged to specify what he considers the remedy to cure the loss, puts his ideas in the hands of the superintendent who will be in a position to help him if he needs help.

There is sometimes a connection between the cleaning room foreman or the casting inspector and the molder that tends to influence the report under the heading "nature of defect." For this reason we leave the entering of the man's name to the foreman in charge, and leave the cleaning room foreman in ignorance of who the molder is that made the bad or defective work. We know that some foremen will neglect this work and fill in the molder's excuse, the foreman's report and the remedy to be applied, without visiting the

HOURLY PROGRESS REPORT

DEPT. DATE

WORKMAN'S NAME	9 A.M.	10 A.M.	11 A.M.	12 M.	2 P.M.	3 P.M.	TOTAL	PATTERN	FLASK

REMARKS

FOREMAN

FIG. 4—HOURLY PROGRESS REPORT

WEEKLY IMPROVEMENT RECORD

WEEK-ENDING

PATTERN	PREV. DAILY PRO.	IMP. DAILY PRO.	INCREASE IN PRO.

DESCRIPTION OF IMPROVEMENT

FOREMAN

FIG. 5—WEEKLY IMPROVEMENT RECORD

molder's floor or seeing the defective casting. But if the foundry superintendent is on the job, he will make it his business regularly to visit one or more molders per day and check up the excuse given on the report. He will also look up regularly one or more defective castings and see how the foreman's report checks with the real causes. This will always catch the foreman who is trying to get along without doing his work according to the orders he has received.

This report is effective in creating an efficient foundry organization. It automatically tries out each foreman and puts a record in the hands of the foundry superintendent that can be compiled and used to a great advantage in making important changes in his supervision. Aside from this, if this system is insisted upon and continued from day to day as intended, we know from experience that the percentage of defective and bad work will decrease.

This report is not intended to be used in connection with the foundry cost system, unless the cost department can use it without any changes. It is designed for the benefit of the foundry management to enable it to handle this part of the organization with intelligence and dispatch.

Hourly Progress Report

When a new pattern is started in the molding room the foreman to whom it is given should make a special effort to secure the best production of good castings per day possible. Often established daily production on the new job falls below the estimate because the foreman in charge does not give the man on the work enough of his personal attention.

In order to force the foreman to visit this man at least once every hour, we require of him an hourly progress report as shown in Fig. 4. He is expected to visit the new job every hour and jot down the progress made by the workman, seeing if he is up to the point in his production he should be. The foreman must find out why and help him to get up to the schedule before another hour has passed if possible.

It is better that a man be checked early in the day and brought to account for lagging, than to wait until the day is over and call his attention to his shortage. If at 9:00 a. m. he is behind he should be helped at that time and as a result his daily production will be greater than if he is allowed to go his own way until the end of the day.

This report is made only on new jobs or old jobs that have been improved. The foreman should not be allowed to have the clerk take up this report, as the intention is to get the foreman to this floor at least every hour until the production has been established. And the hourly progress report will show the foundry superintendent what progress is being made, and that the foreman is watching the job.

Fig. 5, the weekly improvement record, is a blank that will work wonders if the right force is put behind it. Every foreman feels that he should receive credit for any improvements he makes in his department and it is a pleasure for him to be able to turn in a report covering such progress at the end of the week, which he knows will be placed on file to his credit.

The fellow that is not ambitious but is aware of the fact that there is a weekly improvement report blank being used in the shop, feels that he must, at least occasionally, turn one in and this puts him to work trying to create something that will keep his name on the list of progressives. If each foreman turns in one substantial improvement report per week, the organization is effective and the foundry superintendent or manager has reason to congratulate himself.

Foreman's Personal Schedule

There are many good men who would make efficient foremen if they were given more instructions on how to plan their work. The writer has developed good foremen out of men who were working themselves to death and accomplishing nothing by preparing for them a personal schedule, specifying what they should do at certain hours in the day.

For instance from 7:00 a. m. to 7:30 a. m. visit every molder and see if he has the necessary equipment or a job to start, etc. From 7:30 to 8:00 a. m. put men to work. From 8:00 to 8:30 a. m. order cores for the following day, and take up with the core boss any complaints about his cores. From 8:30 to 9:00 a. m. visit every molder's floor whether you have any business with him or not. This schedule should be made out to take care of every half hour of the day.

It is not the intention to make a foreman do his work according to the time laid out. In the long run this would not be practical, but this schedule is a secret between the foundry superintendent and the foreman, and the foreman quietly follows it until he has formed a habit of attending to his work systematically. He finds that he can execute the tasks specified on his schedule in one-fourth the time he has given himself, and he naturally asks himself "now what will I do to fill in the balance of the half hour?" This plan gets him around the shop driving the work instead of letting the work drive him.

In organizing a foundry it is necessary to make many foremen. They cannot all be hired, and sometimes a little help of this kind is all a man needs to make him a valuable asset to the company. The foundry superintendent should be familiar with his foreman's duties so he can outline a schedule of this kind when it is necessary.

The coremaking connected with the production of gray iron castings plays an important part in their quality and cost. The core department should be laid out in such a manner as to permit of the cores being made in one room and assembled in another. The two departments can be separated by locating the drying ovens between them with doors at both ends of the ovens, one set of doors to open on the coremaking side and the other set of doors on the assembly side. This plan will allow the coremakers to load the oven trucks in their room and place them in the ovens; it will also allow the assemblers to unload the trucks in the assembling department without interfering in any way with the coremakers. By separating the coremaking from the assembling we automatically create a core inspection department of the assemblers.

When a coremaker assembles the cores he makes he will naturally cover up any defects he discovers that are the result of his carelessness and by this act often causes the molder to produce a defective casting. When the coremaker's work is assembled by another workman who is obliged to put his mark on every set of cores he assembles, he does not hesitate to report unreasonable defects in order to escape having his work condemned. The same is true where cores are blacked and joined by the assembling department. Aside from this great advantage of having the additional check on the coremaking, we have found that better work and more work can be done by dividing the department in this manner.

The coreroom should be laid out with a view to locating the sand-mixing and sand-reclaiming equipment in the most convenient place for obtaining new material and for delivering mixed sand to coremakers.

How to Prepare Oil for Sand

In mixing oil sand we have found that a better core can be produced with less oil by preparing the oil before adding it to the sand as follows:

Fill a tank or barrel three-quarters full of water and oil, one-third to be oil and two-thirds to be water. Run a high pressure air line into the tank within six inches of the bottom. A short time before the liquid is to be used turn on the air pressure and allow it to blow through the mixture until the tank is filled with foam. This will be an indication that the oil and water have been thoroughly mixed. The foam will settle in a short time when the correct quantity of the mixture can be added to the sand. The sand mixer man must remember that only one-third of the liquid is oil, and make his additions accordingly. This plan enables us to reduce the percentage of oil required to make good cores very materially. The oil when mixed well with the water can be distributed through the sand more thoroughly.

In testing oils we have found that the oil that produces the strongest core does not always produce the soundest casting, and the strongest core does not always stand up the best when surrounded by hot metal. For this reason we do not recommend making any decision on the oil to be adopted as standard until the binder has been tested as to the percentage required to make a firm core that will stand up with the hot metal around it with the least rodding and the least venting. In making these oil tests, we have found that all of the oils are improved by mixing with water by air pressure.

The most effective way to handle the core orders is direct from the foundry office to the core department, having the foundry production man issue these orders. The coreroom clerk should also be the coreroom timekeeper, and he should keep the coreroom production sheet.

A great deal of money is often spent in producing cores that are not used and remain in storage so long that

they become worthless. Also production is often held up because of the complete sets of cores are not made as required to keep the work flowing through the shop. Both of these troubles can be overcome by the use of the daily production sheet shown in Fig. 2.

Where a number of cores of different sizes and shapes are required to make one complete set, we have found it advisable to number the various cores from No. 1 to the number equalling the number of cores in the set. Wherever possible this number should be put on the box where it will show on the core. This helps the production record, and makes it easy to make separate piecework prices. Also it helps to identify the core for inspection and delivery.

The delivery of cores costs more than we sometimes realize. By the use of electric trucks it is possible to reduce this cost 50 per cent. In order to use the trucks the gangways must be kept clean and smooth all through the shop and special core racks should be made to take care of a large number of small cores. These racks should be provided with shelves that will accommodate the core trays.

The assemblers should load these racks with the cores that are to be used by a number of molders working in one part of the shop within a few yards of each other. The electric truck picks up the rack and takes it to a point where it will be most convenient for all of the molders whose cores are on it. Large cores, such as transmission case and crank case cores, or assembled cylinder cores should be placed in special cradles. These cradles are loaded onto the skids and the skid carried to the molder's floor by the truck. Where a large floor is using a great many cores a special rack should be provided to take care of enough small core trays to enable the core department to deliver a separate tray of cores for each mold. This plan helps the molders and prevents excessive breakage. In order to avoid confusion each molding floor should be numbered.

Organizing a Girls' Core Room

The organization of a girls' coreroom should receive careful study in order to secure maximum production. This department is too often limited to small cores because they are light and can be handled by girls. This is a mistake. A system of having the cores carried to the ovens, and the dryers and plates to the workers by men will relieve the girls of the heavy lifts, except in cases where the coreboxes and plates are too heavy for them to roll-over and draw. This is taken care of in cases where the cores are large by the use of a roll-over molding machine that will roll-over and draw the box. However, there are a large number of cores that are too small for the molding machine and too large and heavy for the girl to roll-over and draw continuously. For this work we have discovered a effective core drawing machine now on the market that takes care of all of this intermediate work, and adds to the number of cores that can successfully be produced by girls or by green men up to fully 100 per cent. Using this machine it requires no skill to successfully draw a corebox from the most delicate core. The machines are portable and can be moved to any bench where the operator has difficult or comparatively heavy work to make. In producing cores that must be perfect and free from tool patches, variations in size, etc., also cores wanted in large quantities, this machine simplifies the work and makes it possible for women or new beginners to do it satisfactorily.

Women will work more steadily than men. While they will require more supervision and more attention in the way of help in lifting, etc., they become most proficient. They are a decided success in the production of cores for tractor or other similar castings. As assemblers we find them in many cases superior to men. The utmost care must be exercised in selecting the forelady. She should be a disciplinarian rather than a good coremaker.

Core Department Rules

In creating a coreroom organization, we have found it helpful to establish a few rules for this department and insist upon their being observed at all times. Some of them are as follows:

1.—Core assembling department must unload all core-oven cars, and return all core-plates and core-dryers to the coremaking department.

2.—Rod and wire cutting or straightening must not be done by coremakers.

3.—Coremakers will be paid for cores accepted by the oven-man only, who will provide each coremaker with core checks as he receives the cores on the receiving bench in good condition.

4.—Cores rejected on account of improper venting will not be paid for whether or not they have been accepted at the oven.

5.—Core assembly piecework cards must be signed by the inspector.

6.—Cores must not be delivered to the molder's floor if he is absent, or if he is not going to use them the day they are delivered.

7.—Coremakers will not receive credit for an overproduction of more than 10 per cent of the number called for on the daily schedule.

8.—Sand mixers must demand a sand ticket for every load of sand they deliver to the coremakers. Coremakers will be provided with a sufficient number of sand tickets to produce their work by the foreman. Sand mixers must turn in all tickets they receive daily with their piecework slip to enable the timekeeper to check the work.

In selecting molding machines it is advisable to consider the following: A simple machine plus brains equals more than a complicated machine. A machine is often installed by the alluring statement that it rams the mold, rolls it over, draws the pattern, and does a great many other things automatically. There are few cases on record where a molding machine regardless of the make did satisfactory work the first few days it was started. It takes more time and more study to get a molding machine job started properly than it does to start an ordinary floor or bench job. Molding machines will not eliminate all the foundrymen's troubles. They do not help, but become a detriment if we forget to use brains behind them.

The usual objections to the installation of molding machines are as follows: We have not enough work of the same pattern to use machines. Or, we have tried machines and found we do not need them because our men make just as many molds on the bench or flor as the did on the machines. These statements are erroneous. To the first objection we will reply, a machine properly directed can have the patterns changed on it a dozen times a day and be a paying investment. For instance, compare the bench-molder with his two rammers, with a molder with a hand squeezer, or draw a comparison between the molder with the hand squeezer and the molder with the power squeezer. The molder with his two rammers must pound against the hand squeezer where all that is required is one pull of the ramming lever. The man operating the hand squeezer must pull his lever against the simple turning of the valve handle, which gives the power squeezer man a great advantage over him.

Consider the wide difference between the molder with his two hand rammers and the operator with his valve handle in actual labor required, and I know that you will agree that the foundryman who is content to have his men demonstrate to him that they can produce as much work by hand as with a machine is being misled. Probably machine production has been intentionally slowed down in order to make a comparison that will defeat the installation of machines in the foundry.

If the molders are making 100 molds by hand work, it is safe to say they can make 200 with the hand squeezer. If they are making 200 molds with the hand squeezer they can make 250 or 275 with the power squeezer.

There are a few jobs that can be made more successfully on the bench or floor with hand rammers, but the number that cannot be worked on the machine at a decided saving is generally much less than reported by the man in charge, if the latter does not care to use his brains to develop the molding machine in his work. The most effective plan in installing machines in a foundry where the foreman is not enthusiastic, is to employ a molding machine expert for a period to supervise the selection and fitting up of all patterns, and to establishing production on the machines.

A Corliss engine-bed weighing 15 tons can be rammed on a jolt machine in a moment. The same work done by hand would require one day's work for two molders and two helpers.

Where a large number of machines are used, there should be a number of emergency machines that are operated only when one of the regular machines is down for repairs. This avoids delays in the production.

When Pouring Off

The molds required to produce 100 to 125 tons of small castings cover considerable floor space unless a plan of continuous pouring is established. This cannot always be done.

In order to avoid cutting down the molding time and to do away with the old scheme whereby every molder stops molding when the blast goes on, an effective plan is to pour off in sections. Lay the shop out in sections, each section to cover the number of floors required to take care of the metal as fast as it is melted with the exception of probably a few floors that must have first iron every night. Assuming that the shop is large enough to divide it into five sections, the operations would be as follows:

All molders working in section No.

1 will begin pouring as soon as the iron is down. When section No. 1 is poured off the men in No. 2 will receive their iron. Sections Nos. 3, 4 and 5 follow according to their numbers. On the second day of the week section No. 2 gets the first iron with sections Nos. 3, 4 and 5 and No. 1 following; on the third day section No. 3 pours first and section No. 2 is last.

The section pouring the first iron is the only one that should be allowed to stop molding when the first iron comes down. Their production will be less than the sections that follow them, but on the next day they are the last to receive iron and will have the greatest production. This plan increases the daily output per man and keeps the men satisfied. It is an important thing that the men in the section pouring first be allowed to go home just as soon as they have poured off. This acts as an incentive and induces them to enter into the scheme readily.

This plan has many advantages over the usual plan of giving every part of the shop iron at the same time. The men are not heated up so long, the ladles do not get cold between deliveries to their floor; the night men are able to start quicker with their work without interfering with the molders, and the production is greater. The molders learn to plan their recreation and amusements to take place on the night they know they are to get first iron. We have found the overhead trolley the most effective method for delivering iron to the floors for this class of work.

Pay for Pouring

A piecework system for delivering the metal is valuable. The cupola man at each cupola is provided with ladle checks, and as each man leaves the cupola with a trolley ladle full of metal for some part of the shop, the cupola man presents him with one of the checks. The ladle man later turns his checks into the timekeeper, who gives him credit at the price per ladle agreed upon. With ladle men working piecework there is no trouble experienced in getting the ladles back to the cupola in time. In fact these men continually urge the molders to hurry with the pouring so they can get back and get another check. With this plan a part of the organization the number of ladle men required to deliver the iron is reduced 50 per cent.

The cleaning department should be planned to allow the rough castings to be delivered to the tumbling mills and from the mills to the chipping benches without hauling, and similarly from the chipping benches to the grinders and from the grinders to the delivery trucks or conveyors.

Every tumbler should be a complete unit in order to keep it working all the time. The best plan is to arrange a row of tumblers in line with the loading side opposite from the unloading side. The rough castings from foundry should come in on the loading side and the chipping benches should be located about 36 inches from the mills on the unloading side.

The mill men should handle their work as follows: Load mill No. 1 and start it. Then load Nos. 2, 3, 4, 5 and 6, starting each one as soon as it is loaded. If a careful study is made of the work before the number of mills two men can take care of is decided upon, the first mill will be ready for unloading by the time the last mill is started. As soon as the first mill is unloaded it must be reloaded and started before mill No. 2 is unloaded. Mill No. 2 must be unloaded and started before mill No. 3 is unloaded and so on all the way down the line. This plan keeps the mill men busy and allows only one mill to be idle at one time. This always reduces the number of mills required to do the work 100 per cent under the old method of starting them together and stopping them together, as in cases where a battery of mills are driven with one shaft.

Saving Transfer Time

The plan of unloading the mills directly onto the chipping benches provides a good check on how fast the chippers are handling the work. If the benches are loaded full of tumbled castings, it is an indication that the chippers are lagging or there are not enough men on the job. If the benches are empty it is evidence that the mill men are too slow or have too many mills to take care of.

The same plan can be applied to the sand-blasts. We will not go into detail regarding this department further than to say we have found after a great many experiments that a decided saving is effected in the cleaning room by making a careful study of the quality of the plumbago and core wash used in producing the larger molds.

We have found in core washes it is not always the article that sells at the highest price that saves the most money, neither is the cheapest wash most economical. A daily check on the appearance of the castings and the length of time they were milled soon tells what kind of material to use and how to apply it.

Having the patternmaker foreman report to the foundry superintendent does away with the old-time habit of the foundry blaming the patterns for a portion of its losses and delays. It has always been conceded that the foundry superintendent and the pattern foreman should work together, but we have found that better results are obtained when the pattern foreman is working under the supervision of the foundry superintendent. This plan puts the production up to the foundry with no excuse for mistakes, and it has been demonstrated that the patterns come out to the foundry more promptly and are constructed in a manner that makes molding more simple.

The drawings and orders for new or altered patterns are received by the foundry superintendent who specifies how he wants to mold them before turning them over to the patternmaker foreman. When the pattern foreman receives an order for patterns, he estimates the number of hours required to make the pattern, entering the same on his "hours required" report. When the pattern is completed he enters the actual time consumed on the same record opposite his estimate and he and the foundry superintendent note the difference between the estimated time and the actual time. It is only natural that the patternmakers will try to do better than his estimate.

This plan enables the foundry superintendent to know just how his work stands in the pattern shop. He knows how many hours of pattern labor he has ahead of him and how long it will take him to get it done. It also gives him a chance to check up his foreman's ideas of the time he intends to put on a pattern and should it be unreasonable he has an opportunity to make changes.

An organization of this kind is not limited to a large foundry. The manager who has a small foundry in connection with his plant can take over the duties outlined for the foundry superintendent and do some very effective work even though he is not a practical foundryman.

In large shops producing 90 to 150 tons of good castings daily, the plan is ideal as it is merely the problem of the supervision of a number of foundries operating under one foundry head.

The organizing of a gray iron foundry means producing an organization that will work together nine hours per day and that realizes that the key to successful organization is quick action. The machine to get working right, to inspect daily, to keep in repair, to keep well lubricated, is the machine that is composed of the foundry superintendent, the molding room foreman, the core boss, the pattern foreman and every other fellow who has anything to do with the supervision of the work.

Hard White-Core and Gray-Iron Castings

By W. J. Keep

Question.—A large number of our gray-iron castings are too hard to machine. Some of these castings, which are ⅛-inch thick, are white all the way through; in other cases the fracture shows segregated hard spots. As we do not receive our reports until three days after the heats are poured, many hard castings go through before we learn their analysis. We analyze each car of coke as it is received. At present however, we are obliged to mix different kinds of coke. We use both northern and southern pig iron and stove scrap, the proportions being regulated by our analysis reports.

Answer.—In a case of this sort the chemical analysis is of little help in determining the difficulty. We doubt if the trouble is with your coke, although you should try to keep the sulphur in the coke as low as possible. Do not overlook the fact that the first 300 pounds of iron drawn from the cupola has boiled on the sand bottom. In many cases the molders catch this iron in unused ladles in which it also boils. If the iron is hot, it may be used to dry several ladles. If such iron is poured into light work, trouble will be experienced. The iron, however, will usually stand pouring from one ladle to another without producing white spots. The remedy in your case probably lies in pouring the first round of catches directly into the molds. Also it is better to pour the first iron into molds where hard spots will do no harm.

Obtaining Best Results From Use of Chaplets

Removal or Prevention of Rust and Precautions Against Excessive Moisture Essential to Prevent Blowholes—Choosing Types and Sizes for Various Purposes

By Ernest Schwartz

IN making castings that require the use of chaplets the molder frequently is annoyed by blowholes. If asked what caused the blowholes, he probably would say the chaplets must have been rusty, of which there can be no question. A knowledge of the character of this rust and its chemical action when surrounded by hot iron is as important to engineers and machinists as it is to molders. Foundrymen know, some to their sorrow, that to take a rusty rod and quickly push it into a ladle of melted iron will cause the hot iron to fly in all directions. This is due more to moisture than to any other cause, as rusty iron retains moisture, which when plunged in the molten iron generates steam, scattering the iron in its effort to escape. If a rusty rod is heated sufficiently to drive off the moisture and then put into a ladle of iron the iron will seem to boil around it but will not scatter with explosive violence.

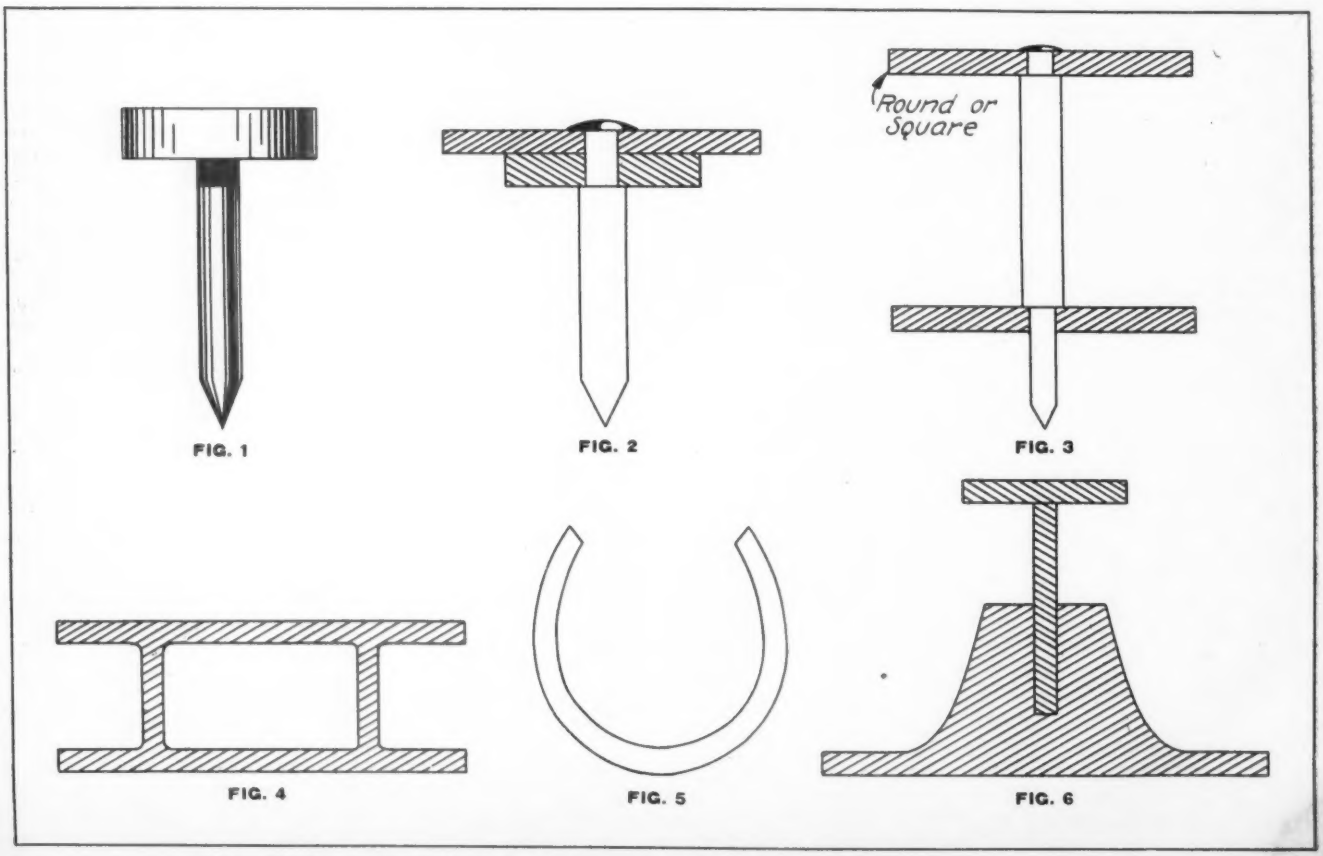
There is another factor to be contended with in preventing melted iron from blowing or boiling when enclosing rusty iron. This is the formation of carbonic oxide gas when the carbon in the liquated iron combines with the oxygen contained in the iron oxide, or rust. The problem in both cases is the same, the prevention of surface oxidation of the chaplet. Under certain conditions polished iron can be prevented from collecting rust or oxygen; the temperature of the iron must not be lower than that of the air, or the air must be dry. If iron is taken from a cold atmosphere into a warm one it will condense moisture and rust is inevitable.

Gas Formation

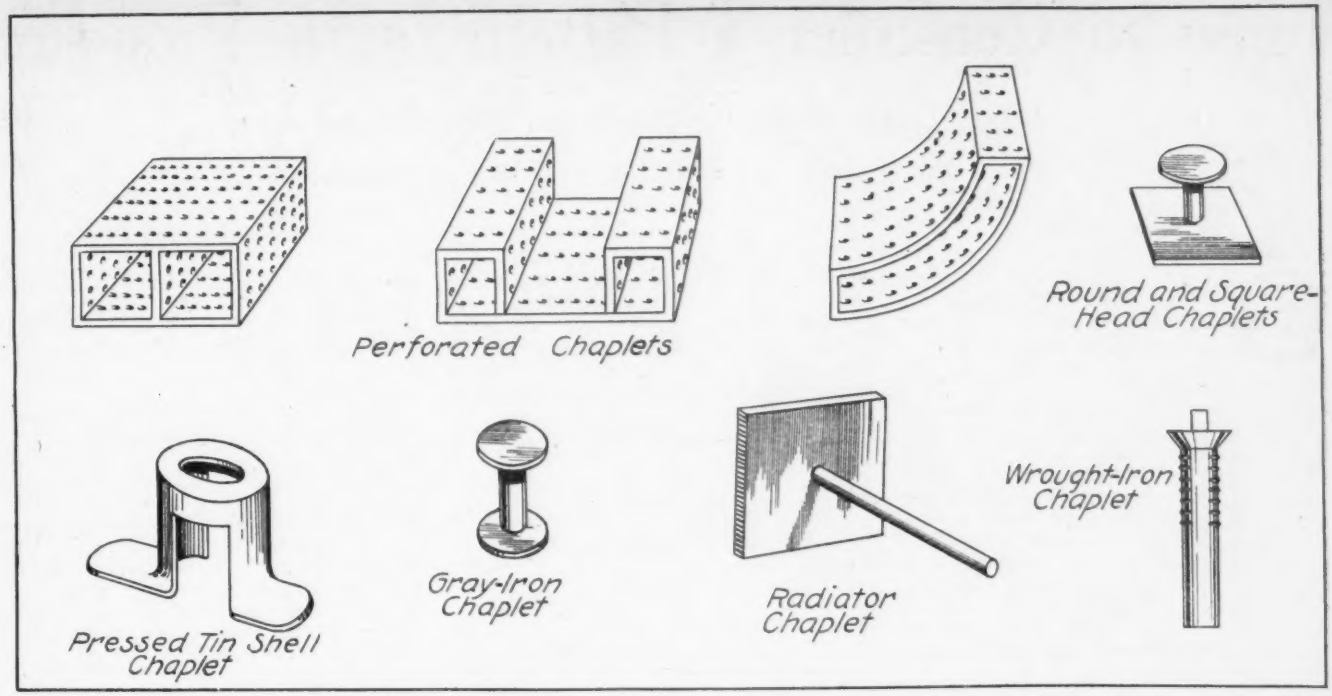
To determine how much carbonic oxide gas is formed in a mold when melted iron comes in contact with rusty iron, a piece of ½-inch round iron, one foot long, was weighed. The rod was then heated sufficiently to cause the rust to become detached, after which the rod weighed 60 grains less. Further test revealed that 60 grains of rust in melted iron will generate 31 grains of carbonic oxide gas, which at 2800 degrees Fahr., the melting point of iron, and a pressure of one atmosphere, will occupy about 600 cubic inches of space, the space occupied by gas depending on the pressure. If a molder, therefore, uses rusty chaplets the damage will be proportionate to the temperature and pressure of the iron around them. Castings seldom have blowholes on their lower portions at or near the point of contact with the chaplets. It is on the top, or cope part, where there is less pressure, that blowholes are found.

Why is it that where the greatest pressure exists the gas escapes the easiest and without causing blowholes? Because the lower portions of the mold are usually the first to be filled and the iron there is hotter and cleaner than at the top. If the chaplets at the bottom cause the iron to blow or boil the gas escapes upward through the iron and comes out of the mold at the runners or feeders. But should the iron boil or blow around chaplets in the upper sections of a mold, blowholes will result, because the temperature of the iron there is such that this excess of gas or steam cannot be so readily released. The size of the cavities will depend on the amount of gas thus confined.

Chaplets are often kept in molds two or three days before the molds are cast. In such cases they are likely to get rusty, especially if the molds are made of green sand. The molder may paint or varnish the chaplets to prevent oxidization but the paint or varnish sometimes creates more gas than would the oxide. The paint also may be of such a nature



SINGLE, DOUBLE-HEADED, CIRCULAR SPRING AND STAND TYPES OF CAST AND WROUGHT IRON CHAPLETS



CHAPLETS MAY BE A BOON OR CURSE TO THE MOLDER, DEPENDING ON THEIR CONSTRUCTION AND THEIR FREEDOM FROM RUST, THE PROLIFIC SOURCE OF CAVITIES IN CASTINGS

as to hold moisture so that the melted iron causes a cushion of steam to form around the chaplets.

About the best preventative of this source of trouble to the foundryman is to have all the rust removed from the chaplets and then to have them tinned, which can be done to advantage for a standard class of work. Aside from eliminating the danger of rust, the affinity of tin for iron is said to make the iron more susceptible to heat. Pieces of tin are often thrown into ladles of iron to make the iron more fluid, the fact that an admixture of one metal to another frequently lowers the point at which either metal fuses when by itself being well known.

Using Loam Chaplets

For castings in which it is essential that the upper sections be sound, it is well to use a loam chaplet. This is made by taking solid iron, wrought or cast, and daubing the surface exposed to the melted iron with a thin coat of loam. This will leave a clean hole in the casting, which the machinist will have to tap and plug, but there will be no danger of blowholes. In using such chaplets pieces of iron can be placed on top of the core arbors so as to come even with the face of the core, the chaplets resting on iron instead of on sand. By this method fewer chaplets will be required to hold a core, and the fewer the chaplets the better and stronger the casting.

Red lead mixed with turpentine is one of the best paints for chaplets. A thread may be cut on the stem of a chaplet and painted with red lead with excellent results. Chalk, coal tar, oil, asphaltum, etc., which frequently are used on chaplets, are not so efficient as red lead. In some foundries cast and wrought-iron chaplets are used extensively. Cast-iron chaplets are the best to use on castings that require finishing, as the melted iron adheres to them better than to wrought iron. In some cases where castings are well finished the chaplets cannot be seen. Cast-iron chaplets can be made in any shape or size and used in castings from ½-inch to 3 inches in diameter, but care must be taken not to set them where the gates will cause the iron to run against them, as they melt readily.

In the accompanying illustrations, Figs. 1, 2, 3, 4, 5, 6 and 7 show types of wrought and cast-iron chaplets convenient and suitable for most classes of work. Fig. 1 is a cast-iron chaplet that can be made readily from ⅜-inch to 1-inch in diameter and any length required. It may be made by ramming up a deep flask having a smooth joint and after the cope is off bedding-in the head and driving down the long stem to any desired length. It should be notched with a chisel on each side before it is broken off as it may break below the surface of the casting if roughly handled.

Fig. 4 shows a double-headed chaplet, particularly for use on loam and dry-sand work. A pattern will be required for each size required. Fig. 6 shows a cast-iron chaplet and stand which is handy for loam, dry or green-sand molds. The face of the stand is set against the pattern and rammed up or built up in the brickwork. The only objection to using this stand is that it will chill the casting, for which reason the stand should not be used for castings made of hard iron. The stand had better be cast solid and the hole for holding the chaplet drilled out. When setting the chaplet, if it is too long break off the end of the stem and if it is too short put sand in the hole. Iron flasks for special jobs often have holes drilled in the bars to hold chaplets, saving much time and labor.

Fig. 2 shows a wrought-iron chaplet, having a large double head riveted to the stem. This type is better than that having only a single head, especially for large and heavy cores. A blacksmith can put a shoulder on the round stem and weld on a nut, making the head of the chaplet 3 or 4 inches in diameter, which is better than a head riveted on over a small shoulder. Chaplets not requiring large heads can be made cheaply in a machine for heading bolts.

Fig. 3 shows a double-headed, wrought-iron chaplet, having a sharp stem, to be used on loam and dry-sand work. The top head is riveted on and the lower one is forced up the stem to the shoulder. Fig. 5 shows a spring chaplet made from hoop, sheet, or plate iron, bent with the grain of the iron. This is handy for placing between cores where it would be difficult to retain an ordinary type of chaplet.

Fig. 8 shows a variety of chaplets or anchors, which, except for special requirements, the foundryman can procure from manufacturers or supply houses much cheaper than he can make them when they are to be used in large quantities.

The Manganese Industry in 1918

Reports recently received by the United States geological survey from operators of deposits of manganese and manganiferous iron ore show that domestic mines now supply nearly one-third of the high-grade manganese ore needed in this country —an extraordinary increase over the production in 1917, when the domestic mines supplied only about one-sixth of the high-grade ore needed. During the first six months of 1918 the shipments of ore containing more than 35 per cent of manganese were 136,554 tons, and ore of this grade was in October being shipped at the rate of about 28,000 tons a month, or 336,000 tons a year. It is estimated that the total shipments of ore of this grade in 1918 will be about 324,000 tons. During the first six months of 1918 the shipments of ore containing 10 to 35 per cent of manganese were 314,137 tons, and it is estimated that 832,866 tons of like grades were shipped during the year.

How to Construct a Pattern for a Propeller

Detailed Graphic Methods for Obtaining the Slope, Pitch and the Face Curve of Cants in Laying Out a Pattern Are Explained

By Edward Leslie

EVERY workman in the exercise of his art should be provided with the proper tools and should possess a thorough knowledge of the structure which he is to produce. The layout of propeller patterns has been explained by a wide variety of drawings and descriptive matter, some too complicated for ready interpretation. The following methods are presented as the most simple and practical from among this large number. A simple three-blade propeller, 48-inches in diameter is chosen to demonstrate the general layouts which are applicable to all sizes up to this limit. Fig. 1 shows one of the blades in section with the principal dimensions given. The dotted line *A-A* is the contour of the outer edge of the blade and *B-B* is the developed edge. The pitch which is the distance the propeller travels forward in one complete revolution is 50.24 inches.

The developed section layout is shown in Fig. 2. The black sections indicate the respective thickness of each cant or glued layer from which the pattern is built. These sections are not all drawn to their full length as confusion would result from overlapping. The vertical lines are drawn perpendicular to the center line of the hub, intersecting at the distances chosen and indicated in Fig. 1. The drop aft, 3 feet, is measured at the extremity, perpendicularly to the horizontal center line, and this point is connected to the intersection of the two centers by the line *X-Y*. The pitch point, which in every case is a distance

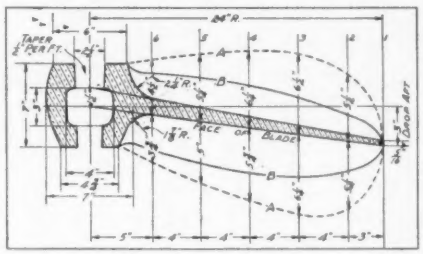


FIG. 1—GENERAL DIMENSIONS FOR A THREE-BLADE RIGHT HAND, 48-INCH PROPELLER WITH A 3-INCH DROP AFT

equal the propeller pitch divided by 6.28 is next measured from the intersection point on the vertical center line. The points *J, K, L, M, N* and *O* are then measured from the point *P* by the following method:

The point *J* is distant from *P* by the length between the horizontal center line and the intersection of the line *X-Y* with the vertical line *1*. In a like manner the length *K-P* is equal to the length of the line connecting the intersection of *X-Y* and line *2* with the horizontal center line. The other points, *L, M, N* and *O* are determined in a like manner.

Then through the intersections previously noted for the determination of the lengths *J-P, K-P*, etc., namely the respective intersections of the vertical lines *1, 2, 3*, etc., with the line *X-Y*, draw lines from the corresponding points on the vertical line of centers. That is, connect *J* with the intersection of line *1* with *X-Y*, as shown, forming the line *J-A;* then draw *K-B*, etc. These lines give the slope of the propeller at these given sections, as shown in the outline formed by the black segments in Fig. 2.

Fig. 3 indicates the development of the face curve of cant *7*, Fig. 2. With the respective distances of the lines *1, 2, 3*, etc., from the center as radii, the circular segments shown by full lines are drawn. Then the lines *J-A, K-B*, etc., are constructed in the same manner as described in the development of Fig. 2. With the intersection of the vertical line *1* and horizontal center line as a center, and with the distance from this point to the intersection of *J-A* with the horizontal center line as a radius, the dotted segment is drawn.

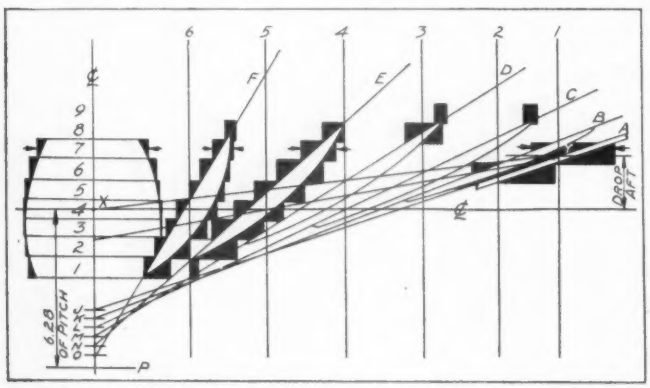


FIG. 2—METHOD OF DEVELOPING SUCCESSIVE SECTIONS OF THE PROPELLER SHOWN IN FIG. 1

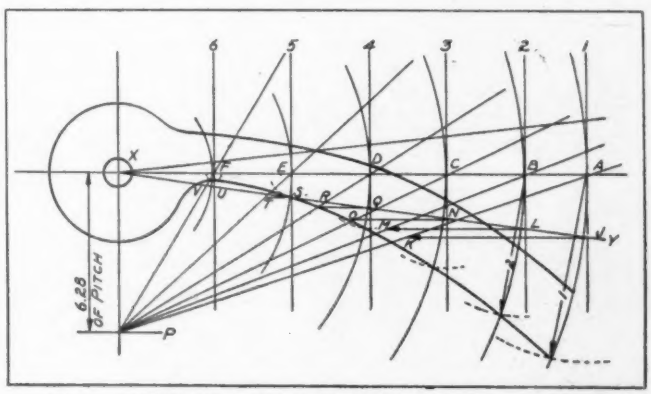


FIG. 3—CONSTRUCTING THE FACE CURVE OF CANT 7 OF FIG. 2

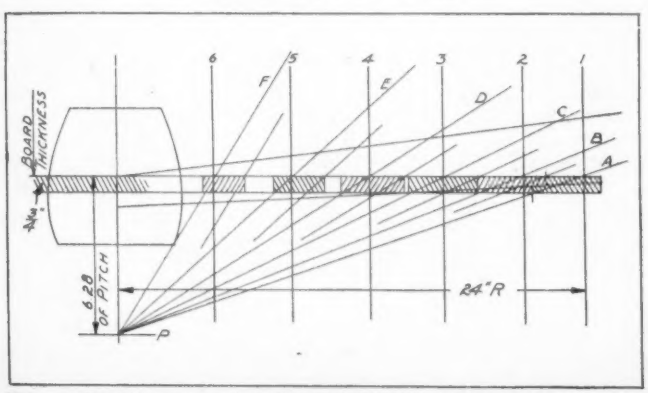


FIG. 4—METHOD OF DEVELOPING SUCCESSIVE SECTIONS OF A TRUE SCREW PROPELLER

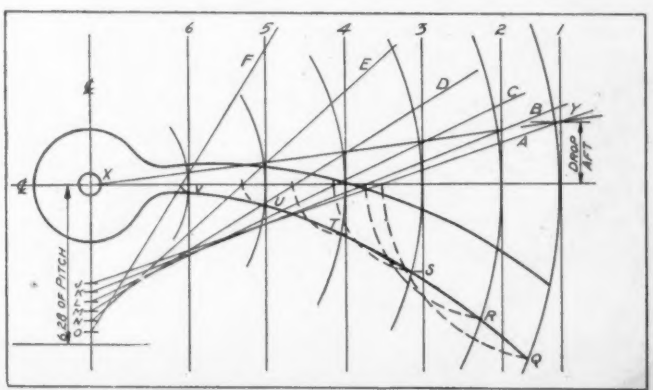


FIG. 5—SECOND METHOD FOR LAYING OUT FACE CURVE FOR A SINGLE CANT

At the intersection of this dotted segment with the first of the full line segments the point *Q* is located. The points *R, S, T, U* and *V* are located in a similar manner and through them the connecting line gives the face curve for cant *7*. The face curve of each succeeding cant is the same. Draw the hub diameter and add each width in turn to the face curve, the widths of each cant being taken from Fig. 2. As will be noted, all the sections are not drawn on Fig. 2. Note that cants *6* and *7* are the only ones carried to the extreme diameter. Cant *1* only takes two and one-half sections, and cants *8* and *9* do not extend to the hub.

The methods previously described are applicable only to small blades. The following method is perhaps more rapid and accurate, but requires more experienced judgement unless accurate sections are given by the draftsman.

Fig. 4 outlines a method of obtaining the width of cant and the face curve for forms of construction where the cants are duplicated. In this case no drop aft is established. The blade thickness is drawn on the horizontal center which is the face of the blade. The lumber thickness has been reduced in this case from 1 to ¾ inch, but lumber of any thickness may be used. As the drop aft is not considered, all pitch lines run to the single pitch point *P* which is distant from the intersection of the line of centers by the amount of the pitch divided by 6.28. The pitch lines are drawn from this point *P* through

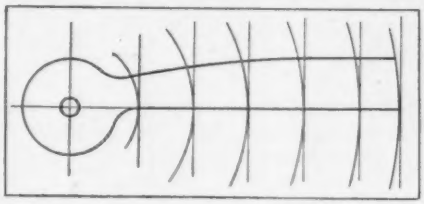


FIG. 6—LAYOUT FOR A TRUE SCREW BLADE SINGLE CANT

the respective intersections of the vertical lines *1, 2, 3*, etc., with the horizontal center line. The intermediate lines represent the slope of each face at the respective sections. The layout of each cant in conjunction with this form of construction is shown in Fig. 5.

The drop aft in this case is established below the horizontal center line, and the radii are established as in the case explained in Fig. 3. Draw the line *X-Y* connecting the intersection of the two center lines with the point determining the drop aft on the line *1*. Then through the intersection of *X-Y* with the succeeding lines *1, 2, 3*, etc., draw the parallel lines *J-K, L-M, N-O, Q-R, S-T* and *U-V* from the vertical lines *1, 2, 3*, etc., to the respective pitch lines. With these respective lines as radii and *A, B, C, D, E* and *F* as centers, find the intersections with the radii previously drawn. These intersections determine the location of the face curve. Each cant is alike except for the change necessary to accommodate the change in the hub curve. Each cant must have a hole bored in the hub to fit the spindle used in building and in molding. This hole must be made to suit the standard foundry spindles.

Fig. 6 is the layout for a true screw blade, or one which does not have the rake or drop aft. The face of each cant is straight in this case with the width added at each section. The true screw blade is the simplest form, but the blades with the drop aft are the more generally used.

Substituting Manganese for Phosphorus

By Arthur F Braid

THE war has caused an increasing scarcity of phosphorus and its alloys with copper and tin. At the same time the production of brass and bronze, nickel-silver, cupro-nickel and other nonferrous alloys has considerably increased. The manufacturers of these products, therefore, have had to obtain other materials which would serve their purpose, principally as deoxidizers.

Fortunately, such materials as pure carbon-free manganese metal and manganese-copper alloy, were not difficult to obtain. Manganese, in various forms, has been used in Europe for more than a century; in this country, however, when manganese was first employed, and for a long time thereafter, it was consumed mainly in the manufacture of manganese bronze. Many foundrymen at that time used manganese-copper with the same freedom as phosphor-copper. Although iron enters into the composition of certain grades of bronze it is detrimental to nonferrous mixtures in general; consequently, ferromanganese is not applicable and, therefore, pure manganese metal or the alloy of manganese and copper, technically free from iron and other impurities, is now being used.

The following are the principal elements having an affinity for oxygen: Sodium, potassium, calcium, strontium, barium, magnesium, aluminum, phosphorus, silicon, manganese, iron, zinc and lead. Each metal has its natural flux, or deoxidizer, in the form of metal or nonmetal which will alloy with it and has a strong affinity for oxygen. For example, phosphorus acts beneficially in tin-copper alloys.

From a paper presented at the Milwaukee meeting of the American Institute of Mining Engineers. The author, Arthur F. Braid, is metallurgical engineer, Metal and Thermit Corp., New York.

Within the last few years, particularly since the war began, the great value of manganese in nickel alloys has been demonstrated and one by one the manufacturers of these products have adopted its use. While manganese has not so strong an affinity for oxygen as magnesium, aluminum or silicon, nevertheless it is sufficiently powerful to reduce any oxide of nickel, copper or zinc that may be present in the nickel alloy to be purified.

It is this affinity for oxygen that renders manganese valuable in casting nickel alloys for rolling or drawing purposes, since the oil, burning at the mouth of the mold, is capable of reducing the thin film of manganese oxide that forms upon the stream of metal as it is poured. Aluminum or silicon oxides are not reduced by burning oil, and therefore it frequently happens that castings are dirty when aluminum or silicon is used. With manganese, clean castings result if ordinary precautions are taken in handling the pouring.

It is customary to add the manganese in the form of a manganese-copper alloy having the composition of 30 per cent manganese to 70 per cent copper. The addition to nickel-silver is about 3 or 4 ounces of the alloy per 100 pounds of the mixture, equivalent to about 0.06 to 0.075 per cent of manganese.

In such alloys as cupro-nickel the amount of the manganese-copper alloy should be almost doubled. This quantity introduces about 0.12 to 0.15 per cent of manganese, and to certain grades of nickel-copper 0.25 per cent of manganese is added. The manganese-copper should be introduced into the mixture after all the other metals have been melted and the whole well stirred. The mixture should then be left for a few minutes so as to give the manganese time to act. It will be found that manganese gives excellent results in nickel alloys.

Another important feature in the use of manganese is its strong affinity for sulphur, exceeding that of all other metals. When introduced into a mixture containing sulphur, sulphide of manganese is formed at once and rises as slag to the top of the metal. As sulphur is frequently present in cupro-nickel alloys, the advantage of this property of manganese is obvious. More attention should be given to sulphur in nonferrous mixtures, particularly at the present time when raw materials and fuel are not generally of so high quality as before the war.

In the casting of brass it has been shown that manganese acts best when there is a high proportion of zinc. On the other hand, in red brass phosphorus is used with excellent results because it causes the tin, with which it alloys more readily, to assume a crystalline structure and produces a more homogeneous casting. A number of foundries are experimenting with manganese to take advantage of its hardening effect and thus diminish the amount of tin used in certain mixtures.

The recent tremendous increase in the use of manganese has been brought about to a great extent by the demand for munitions, etc., since, in addition to the various mixtures previously mentioned manganese is used in nichrome, monel metal, aluminum, stellite and other metals and alloys. Probably the most recent use for manganese was in a certain nonferrous mixture which was used for the production of the necessary charcoal for gas masks by the carbonization of various kinds of fruit stones.

Handy Angle Irons for the Metal Pattern Shop

Convenient Devices Which Have Proved Suitable for Use by the Metal-Pattern Maker in Laying Out and Machining His Work Are Described

By S L Cook

PATTERNS must be accurate if the castings are to conform to the customer's drawings. For that reason patternmaking has always ranked as a woodworking trade which requires a high degree of manual skill. With the gradual development of manufacturing, however, came the demand for a more durable pattern material than wood. Thus it was natural for the patternmaker to select a good casting that had been made from a wooden pattern, smooth it up with a file, polish it a little with emery cloth and drill a hole for convenience in rapping.

Such a pattern was considered good enough for all practical purposes. This practice, of course, resulted in a double shrinkage on the pieces cast possibly within reasonable limits. No one expects a patternmaker to work to the one-thousandth part of an inch, but at the same time the metal-patternmaker should produce patterns that are both square and parallel.

When the toolmaker wishes to lay out and machine a jig or fixture casting accurately, he generally uses angle irons and parallel blocks of various kinds for locating his work. As metal patterns with flat surfaces are laid out and machined in the same manner, similar machines and accessories can be employed. For this reason, now that the demand for greater accuracy in patterns is constantly growing, the use of angle irons and blocks in the metal-pattern shop is becoming more common. The object of this article is to explain briefly some of the common, but at the same time useful angle irons and parallel blocks which the writer has seen in up-to-date metal-pattern shops.

A common form of angle iron is shown in Fig. 1. It consists of two cast iron plates made integral and located 90 degrees apart. The absence of ribs makes it possible to clamp work on either side of the upright. While this type is not so rigid as some other it is useful for many purposes. The section of the metal should be at least 1-inch for a 6 x 6-inch angle iron.

Fig. 2 illustrates the same type of angle iron, as shown in Fig. 1, with the addition of two ⅝-inch reinforcing ribs. This insures rigid construction and provides an angle iron that will stay true for a much longer period than the type shown in Fig. 1. The outer surface of the ribs is finished accurately by planing to an angle of 45 degrees. The angle iron shown in Fig. 3 is practically the same as that shown in Fig. 2, except that the angles are 30 and 60 degrees.

Fig. 4 illustrates a hollow, cast iron parallel block, 6 inches square, 9 inches long and 1-inch section throughout. This block should be machined square and parallel on all six sides. The two 90-degree V's are handy for a number of purposes, including the machining of flat surfaces on round stock.

Another form of parallel block is shown in Fig. 5. This block is adapted for many kinds of work. It should be finished on all the surfaces designated. Care should be exercised to see that the sides and ends are square with the base.

These angle irons and parallel blocks are used for several purposes in the metal-pattern shop. Their principal use is in machining work accurately on the shaper, in which case the work is clamped to the angle iron; to drill holes at an angle, and to layout work by means of scribed lines. The last operation is generally performed on the bench, in which case several surface plates should be provided, 12 x 18 inches being a convenient size. These patternmaker's surface plates can be cast solid or ribbed, and finished on the planer. It is not necessary to scrape surfaces to a true bearing, as in tool room practice, since the nature of the work does not warrant this expense. The planing should be done accurately, however, a roughing, straightening-up and a finish cut being taken on each.

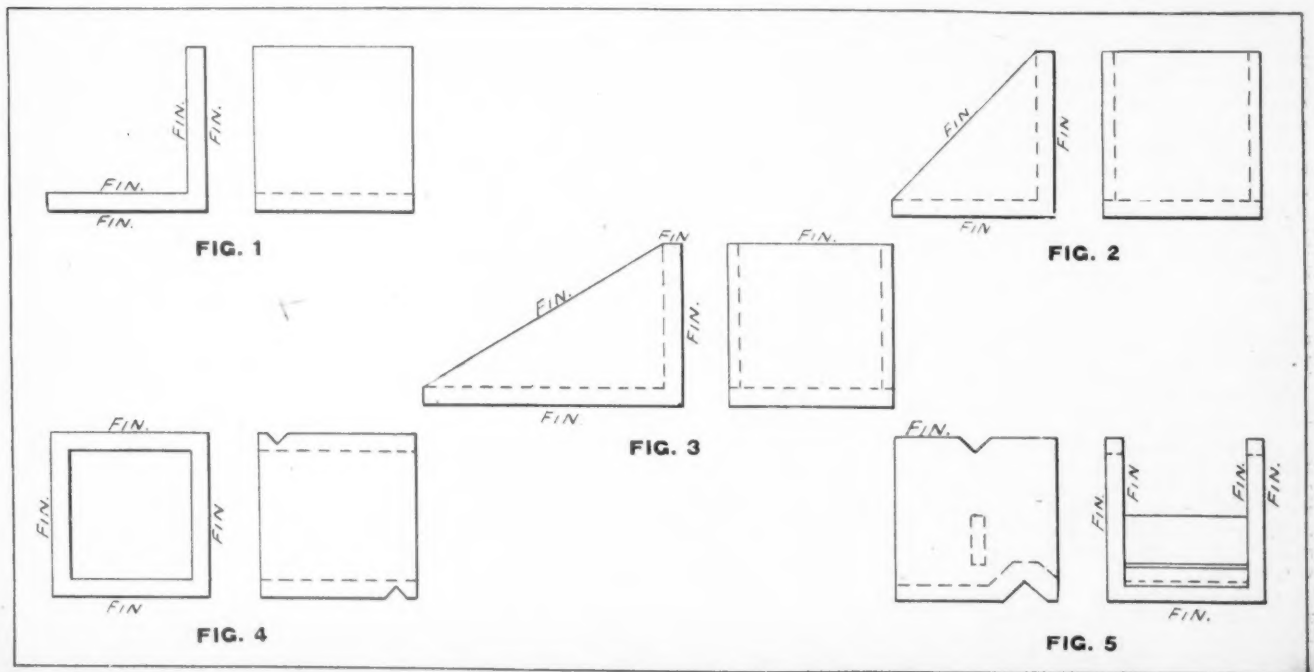


FIG. 1—SIMPLE FORM OF ANGLE IRON. FIG. 2—45-DEGREE ANGLE IRON REINFORCED WITH RIBS. FIG. 3—RIBBED IRON WITH 30 AND 60-DEGREE ANGLES. FIGS. 4 AND 5—TWO FORMS OF PARALLEL BLOCKS

Malleable Iron in Engineering Construction

Engineering Properties and Characteristics of Malleable Iron Which Recommend it for a Wide Range of Uses Are Presented

By H A Schwartz

IRON in its various forms is no doubt the world's most valuable material of construction. It finds its application in the arts principally in two general forms, as steel and cast iron. Both these materials are well known to the designing engineer, and he uses them freely and with confidence as their respective properties adapt them to his needs. A third form, malleable cast iron, or malleable for short, is relatively little known to him and unfortunately appears to be respected to an equally slight degree.

We are accordingly confronted with all manner of peculiar opinions regarding this product and its application to engineering projects. It is no doubt natural that the conservative engineer finally resolves any doubts as to the properties of a material with which he is unfamiliar against that material. Such a course is only good conservative practice from his point of view, but may nevertheless be a decided detriment not only to the producer of the discarded material, but also to the prospective user.

There are many instances where steel for example has been substituted for malleable at an increased cost and a decreased service. The objection in the engineer's mind to malleable iron seems, in the last analysis, to be twofold and to result primarily from a lack of familiarity with the product in question. These two objections are, first, the fact that he appears to be uninformed as to the physical constants and properties of the material, more particularly in a quantitative sense and, second, that he appears to lack confidence in the uniformity of the product as now manufactured and hence doubts whether the material is dependable, even though he has access to data as to its physical properties in individual samples.

A considerable number of years ago, Dr. Henry M. Howe, then of the Columbia school of mines, began preaching the doctrine that the properties of all the iron products might be explained by regarding them as a continuous series of alloys of iron and carbon and this view has since found favor among most of the metallurgists who have had occasion to work in these fields. It may be well, therefore, to approach the subject from this viewpoint in order to explain not only what malleable iron is, but why it is, and to make clear to the technical reader, who may not be versed in the details of its manufacture, the principles upon which the successful making of malleable iron depends. The manufacture of this product, while it is an extremely complex metallurgical process, nevertheless depends on certain broad generalities and laws, a knowledge of which will make possible the continuous production of a uniform product.

In the early stages of the iron industry articles which were to be made malleable, *i.e.*, hammerable, were constructed by the smith of wrought iron. These articles owe their malleability to the fact that wrought iron is practically pure iron. All other forms of iron contain quantities and forms of carbon which interfere with this malleable property. Alloys high in carbon, however, possess the advantage of great fusibility and they are, therefore, capable of being cast in any desired form in molds, instead of being labori-

From a paper presented at the 1918 meeting of the American Foundrymen's association. The author, H. A. Schwartz is connected with the National Malleable Castings Co., Indianapolis, Ind.

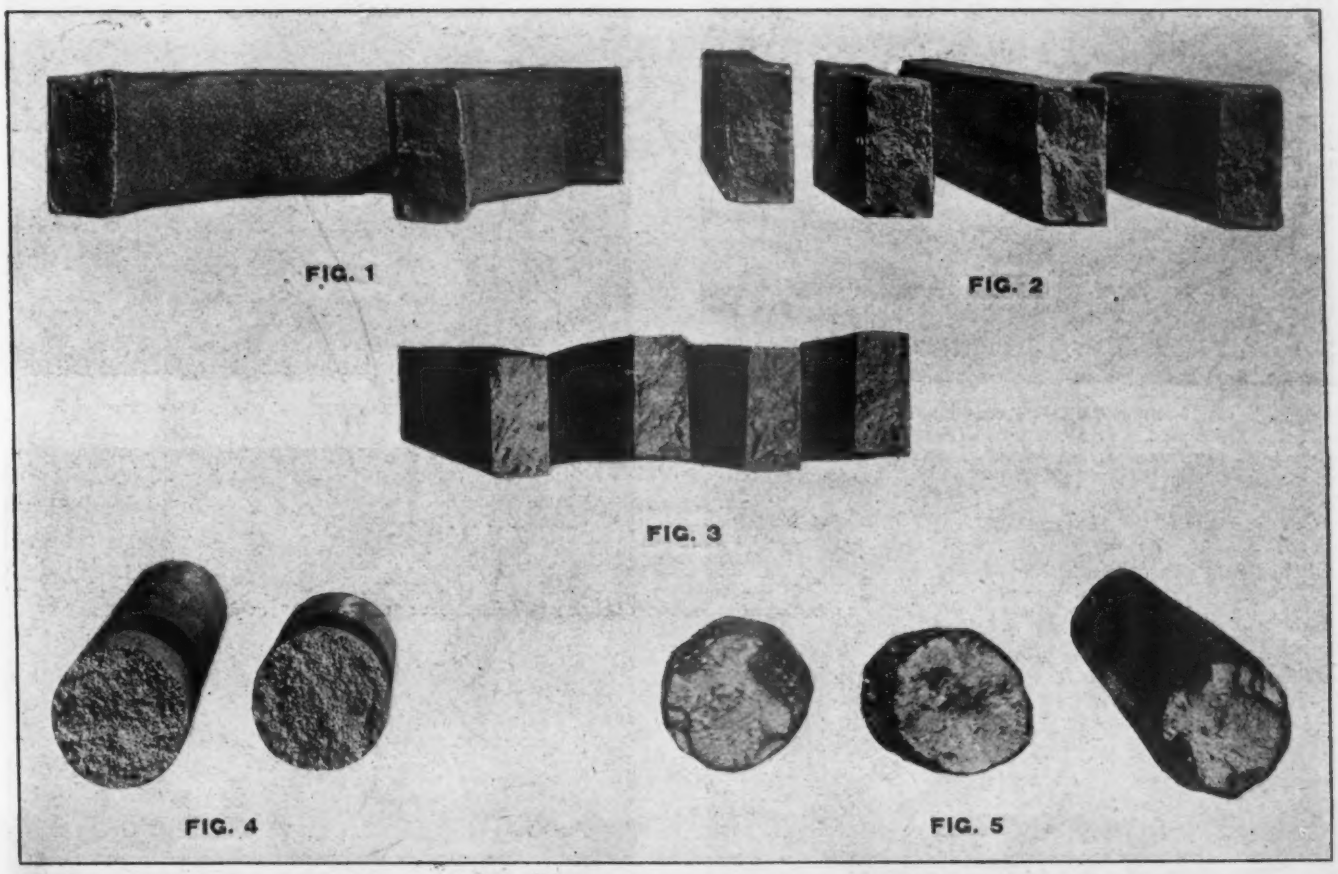


FIG. 1—FRACTURES OF MALLEABLE IRON BROKEN BY BENDING FIG. 2—FRACTURES OF MALLEABLE IRON BROKEN BY TENSION FIG. 3—FRACTURE OF WHITE IRON, BEFORE ANNEALING FIG. 4—FRACTURE OF GRAY IRON FIG 5—FRACTURE OF CAST STEEL

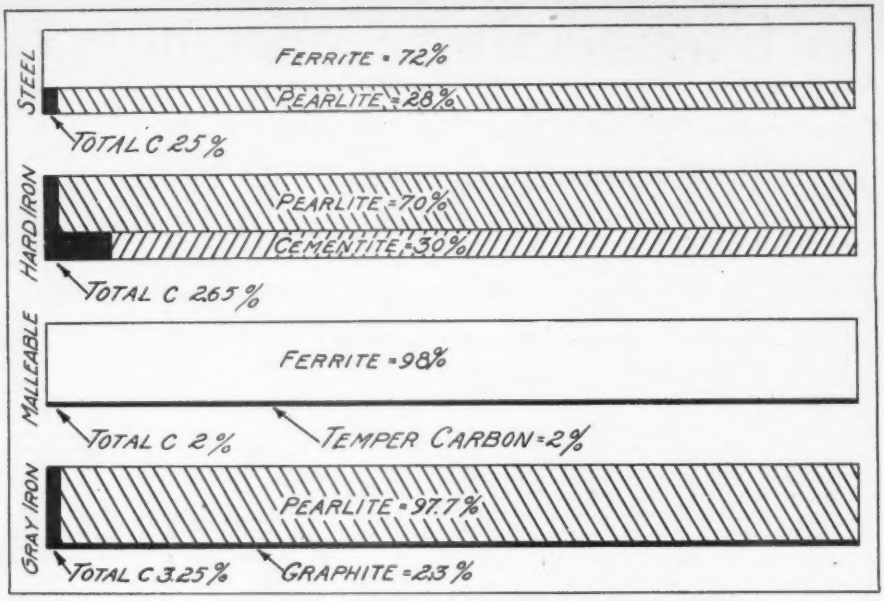


FIG. 6—AMOUNT AND DISTRIBUTION OF CARBON IN COMMON ALLOYS

ously hammered into required shape.

In 1722 Reamur conceived the idea of decarburizing a high carbon casting by heating it to bright redness in iron ore. The resulting product would be a casting of practically pure iron. This invention was the basis of the malleable industry even though the reaction upon which it is based is now but incidental to the process. Some years later, Seth Boyden, working in Newark, N. J., practiced what he supposed to be the same art which had been invented by his great French predecessor. He found, however, that the product of his operations differed generally from Reamur's product in that the material though soft and malleable was black instead of white. Unknowingly, Boyden had discovered an entirely different principle of malleablizing and continued to practice it without any understanding of the reason for his results. From Boyden's work there grew directly and indirectly the modern malleable casting industry. Boyden's work is in brief as follows:

Carbon exists in iron in two chemical forms, in the free state and as a carbide called cementite. Cementite contains 6.7 per cent carbon and is soluble in both solid and molten iron. The solubility corresponds at the melting point to an alloy containing little less than 2 per cent of carbon, decreasing with the temperature until at just about 700 degrees Cent. it corresponds to an alloy containing 0.9 per cent carbon. In cooling below the critical point the solubility abruptly becomes zero.

Solid alloys, such as the foregoing, are in the metastable condition, *i. e.*, there are internal chemical forces striving to bring about rearrangement but unable to do so because they are counterbalanced by the restraining influence of low temperature. The alloy desires to attain the stable condition in which it will consist of iron and iron carbide. The solubility of carbon is less in the free state than in the form of cementite at all temperatures below the melting point. At 700 degrees Cent., the critical point, it is zero instead of being 0.9 per cent. It is a general law that any chemical reaction in a solution will proceed in the direction of formation of that one of the possible compounds which will remove itself from the solution; hence, given the opportunity, cementite will break up into iron and carbon, the latter crystallizing out of the system.

This conversion of the system of $Fe\text{-}Fe_3C$ is called graphitization.

FIG. 7—MICROSTRUCTURE OF UNANNEALED STEEL

FIG. 8—MICROSTRUCTURE OF WHITE CAST IRON

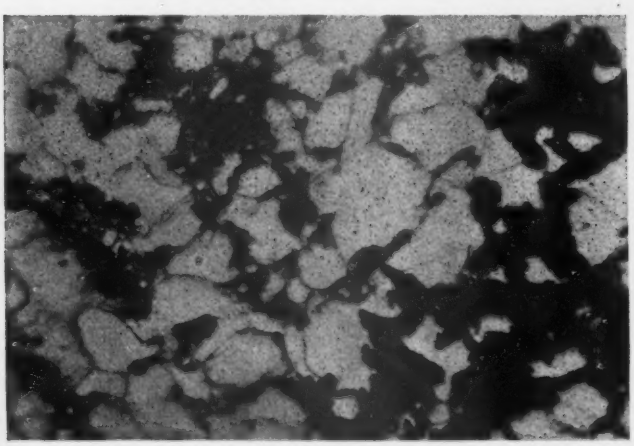


FIG. 9—MICROSTRUCTURE OF MALLEABLE CAST IRON

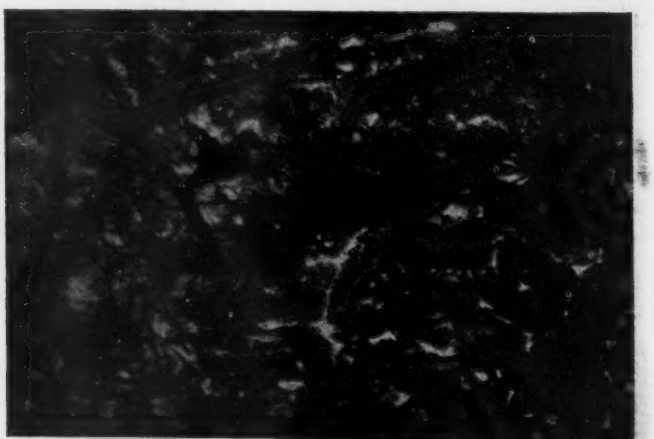


FIG. 10—MICROSTRUCTURE OF GRAY CAST IRON

FIG. 11—TEST BARS ILLUSTRATING PROPERTIES OF STEEL, MALLEABLE IRON AND GRAY IRON

Graphitization is promoted by increased temperature and by the presence of certain other elements notably silicon, aluminum and titanium, and is hindered by the presence of manganese carbide, iron sulphide, chromium, tin and some other elements.

Gray cast iron contains considerable amounts of carbon and silicon. Such an alloy will graphitize quite rapidly in the temperature interval extending about 30 degrees Cent. below its freezing point (1130 degrees Cent.). This carbon crystallizing out under these conditions is formed in a semi-liquid mass of iron and grows into thin plates like fish scales.

Under ordinary conditions the body of the metal contains nearly 0.9 per cent combined carbon and is in effect a fairly high carbon steel. Iron containing less carbon and silicon graphitizes but slowly and if of proper composition will show no graphite when cooled in a mold. Such iron, however, will graphitize if maintained sufficiently long at an elevated temperature. If this temperature be but little below the melting point, gray iron will be produced. If the temperature be chosen lower, say 900 or 1000 degrees Cent., the carbon will separate but being formed in a solid medium is unable to grow into scales of graphite. It then curls into approximately spherical forms and with sufficiently prolonged cooling the result is a pure iron matrix through which free carbon in globules (temper carbon) is scattered.

Black Heart Malleable

This product is modern black heart malleable made by a process very similar to Reamur's but different in principle since no attempt is made to remove the carbon from the metal but to crystallize it out in a comparatively harmless form leaving a body of pure, and, hence, malleable iron. The similarity of this product to wrought iron is close; both are pure iron, the temper carbon of malleable corresponding approximately to the slag inclusions of wrought iron.

In the light of what has been said, it is evident that the problem before the metallurgist is the production of a metal which will freeze without any trace of graphite but which can be graphitized in the subsequent annealing operation. Both of these requirements are subject to well understood chemical laws; the former is one of chemical composition, pouring temperature, cooling conditions, and so on; the latter is one of chemical composition and heat treatment. In both cases they are subjects which can be and have been thoroughly investigated by interested parties, and are conditions which can be accurately controlled. There is, therefore, no guesswork whatever, nor any mystery connected with the manufacture of malleable cast iron, at least by producers of the higher class; such producers understand quite clearly what they are about, what ends they desire to attain and what steps are consistent with the attainment of these ends.

There are to be sure such interruptions or variations of manufacturing technique as are inseparable from any manufacturing operation in general; even the steelmaker and iron-founder also occasionally fail in the execution of their process. Such failures do not result from ignorance or from the application of unknown and unexpected laws, but are merely errors in the execution of clearly understood processes. Nor is the malleable industry more subject to these vagaries than either of its larger and older sisters.

The Iron-Carbon Alloys

All commercial iron products are essentially iron-carbon alloys and differ among themselves according to the amount and form of carbon present. Steel contains but little carbon (around 0.25 per cent in the case of the cast material) which is all combined; white cast iron, that is unannealed malleable, contains approximately 2.6 per cent carbon, also all combined, and is much harder and more brittle than steel. When it is annealed to malleable, the carbon is somewhat reduced, say to about 2 per cent and all converted into the free state in the form called temper carbon; cast iron contains about 3¼ per cent carbon, a considerable part of which is combined, say 0.9 per cent. and the remainder in the free state, as graphite. The form in which carbon is present depends on the presence of other elements and upon the heat treatment as already pointed out. In moderately slowly cooled metal, the following constituents may be expected:

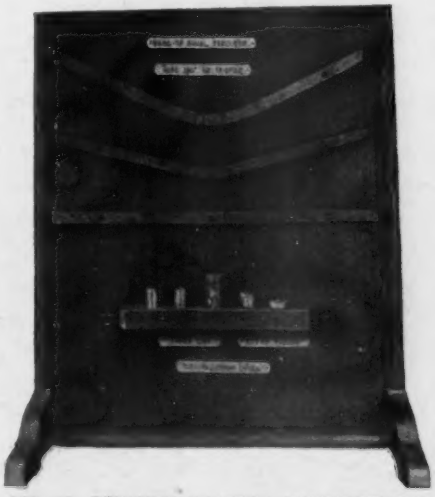


FIG. 12—BEHAVIOR OF STEEL, MALLEABLE IRON AND GRAY IRON IN CROSS BENDING AND COMPRESSION

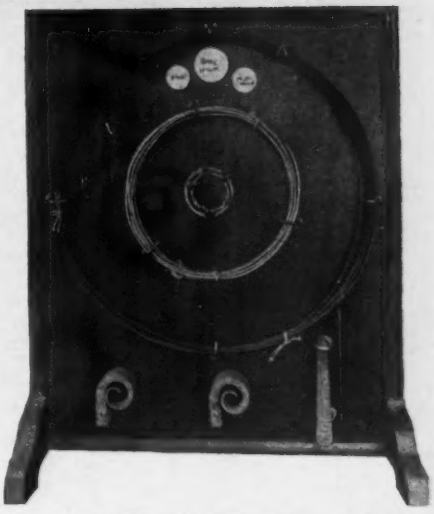


FIG. 13—UPPER PORTION SHOWS ELECTRICAL PROPERTIES OF MALLEABLE, GRAY IRON AND STEEL—AT BOTTOM ARE SHOWN STEEL, MALLEABLE AND GRAY IRON WEDGES DEMONSTRATING RESISTANCE TO SHOCK

Ferrite—Pure iron, a soft, ductile metal of fair strength and great elongation resembling copper in its general physical properties.

Cementite—A definite chemical compound of iron and carbon containing 6.7 per cent carbon; chemically it is carbide of iron Fe_3C. It is very hard, much harder than glass and very brittle.

Pearlite—This ingredient is a mechanical mixture of ferrite and cementite of such a composition as to contain 0.9 per cent carbon. It is stronger, harder and less ductile than ferrite and is known to every one as annealed tool steel.

Temper Carbon—Pure carbon in the amorphous or uncrystallized condition.

Graphite—Free carbon in crystallized form.

All the irons of commerce are made up of one, two or three of the ingredients just mentioned; the low carbon steels containing less than 0.9 per cent carbon are mixtures of ferrite and perlite, high carbon steels and white cast irons are mixtures of pearlite and cementite; gray iron is a mixture of graphite and pearlite, occasionally containing also either cementite or ferrite but never both; and malleable iron is a mixture of ferrite and temper carbon.

The accompanying diagram, Fig. 6, will indicate the amount and distribution of the carbon in the four types of alloys just mentioned, and the corresponding reproductions of photographs Figs. 1-5, show the appearances of the fractures of these materials.

Structure of Iron-Carbon Alloys

The character of the structure of these alloys is more clearly shown in the microphotographs, Figs. 7 to 10. Fig. 7 is an unannealed 0.25 per cent carbon steel in which the light areas are ferrite and the grayish areas approach more or less near to being pearlite. In an annealed casting, the structure would not be nearly so coarse but the ingredients present and their relative amounts would be the same. Fig. 8 shows the structure of white cast iron in which the white areas are cementite and the gray background is pearlite. Fig. 9 is malleable cast iron in which the white background is ferrite in the

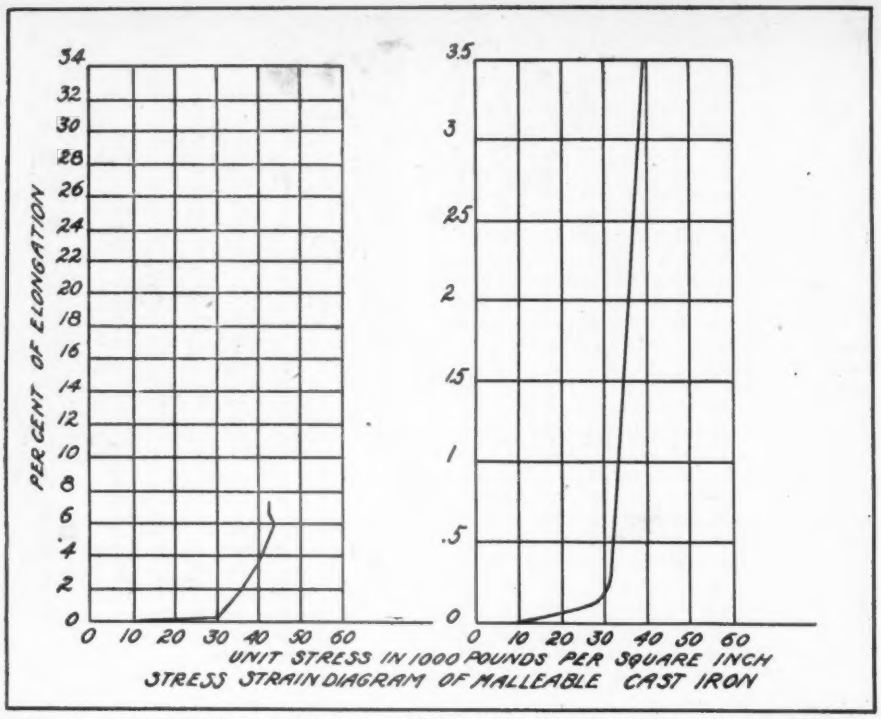


FIG. 14—STRESS-STRAIN DIAGRAM OF MALLEABLE CAST IRON FROM WHICH YOUNG'S MODULUS MAY BE COMPUTED

form of a large number of distinct grains whose outlines can be clearly noted and the gray and black blotches are temper carbon. Note that the temper carbon is aggregated into lumps or nodules, which are approximately globular in shape, although at this high magnification it can be seen that they are not really spherical, but merely approach this shape. Fig. 10 is a gray cast iron in which there will be seen three ingredients. There is a light one, quite probably ferrite, a gray one which is pearlite, and these two constitute a background against which are seen a series of dark gray approximately straight lines. These lines are cross-sections of crystals of graphite and the difference between temper carbon and graphite is solely that the one occurs in round masses and the other in particles suggesting in shape the scales of a fish. It is precisely this difference in crystalline form which constitutes the essential difference between the carbon of malleable cast iron and the carbon of gray cast iron, and which accounts for the differences of physical properties of the two materials.

It will be quite obvious that weight for weight graphite will interrupt the continuity of the metallic masses through which it is scattered much more than will temper carbon. Now any one of these materials has properties corresponding to the properties of the metallic matrix of which it is composed, modified by the amount of interruption that is occasioned by the free carbon which is scattered through it. The carbon has no strength and no elongation. So far as the properties of the material are concerned, it represents merely a hole in the surrounding metal and of course, round holes will weaken the castings less than long narrow slots.

From what has been said, it might be expected that cast steel would be stronger than pure iron since it contains pearlite which is stronger than ferrite. For the same reason, its elongation would be less than that of pure iron and its strength would increase and the elongation decrease the higher the carbon of the steel casting. Malleable iron would be expected to possess a fair elongation since it is made up largely of ferrite, but its elongation would probably not be as great as that of pure iron since the temper carbon will more or less interfere with this property. Malleable iron would be expected to be materially stronger than pure iron and be somewhat weaker than cast steel. Gray iron would be expected to be more brittle than either malleable or steel, both because the matrix is pearlite instead of ferrite and also because the structure is much weakened by the large graphite flakes.

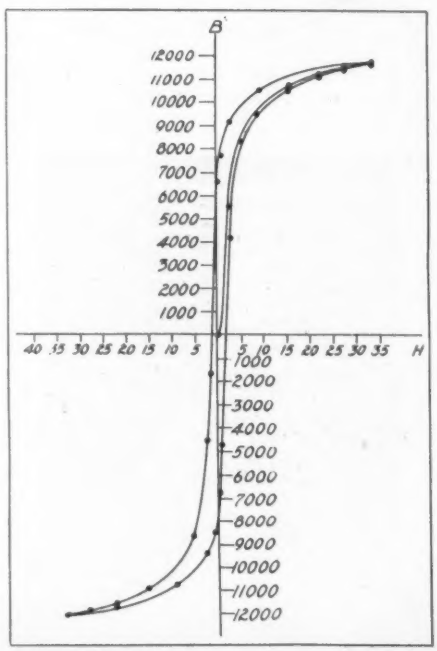


FIG. 15—MAGNETIZATION CURVE AND HYSTERISIS LOOP OF MALLEABLE IRON

In Fig. 10 is shown a series of test bars illustrating the properties of the three materials. All these bars broke with a total load of 16,000 pounds; in other words, the size of the bar was chosen so that the bar should be of the same strength for each material. The upper steel bar had an ultimate strength of 68,000 pounds per square inch and an elongation of 14 per cent; the malleable bar had an ultimate strength of 48,000 pounds per square inch and an elongation of 10 per cent, and the gray iron bar a strength of 22,000 pounds per square inch and no measurable elongation. The malleable bar shown is the American Society for Testing Materials and American Foundrymen's association standard; the two other bars were purposely made of similar shape, though neither represents the proper form of test bar for the material of which it is made.

It is quite possible that the steel bar would have shown a considerable better elongation if a suitable test piece had been used. The three bars show quite clearly, however, the relative size of bars of equal strengths made of the three materials.

Now in engineering design, it is, of course, not possible to load a structure up to the point of failure; indeed, the governing feature is more likely to be the elastic limit. Leaving aside certain controversies of purely engineering interest, the elastic limit might be defined closely enough for the present purpose as being that load to which the material can be subjected without causing it to be permanently deformed. The lower three bars in Fig. 10 are bars of the same material as are shown on the upper half of the board and are of such dimensions that they each will take a permanent set at the same figure, namely, 12,000 pounds. The elastic limits of the three materials are 46,000 pounds per square inch for the steel; 38,000 pounds for the malleable and 13,000 pounds for the gray iron. In this connection note that although the two malleable bars on the board are the same size, the steel bar having the same total elastic limit as the malleable bar is larger than the steel bar which has the same strength. In other words, the elastic limit of malleable iron is nearer its ultimate tensile strength than that of steel. This property is exceedingly valuable as it permits of the use of safety factors in the case of malleable iron lower than in the case of steel. The extremely low value of the gray iron indicates that this material is unsuitable in any event for loads of the character here discussed.

The Stress-Strain Diagram

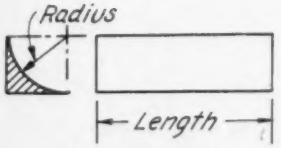
The behavior of metal when subjected to tensile stress is often represented by a stress-strain diagram which plots the increase in length of the specimen compared with the corresponding loads. The accompanying diagram, Fig. 14, of malleable iron, while made before the adoption of the present form of bar, will give an idea of the form of curve for this material. From this curve can be derived the Young's modulus of the

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

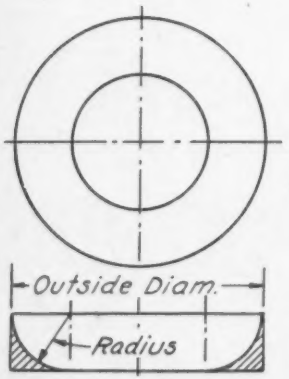
Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note book form.

WEIGHT OF FILLETS

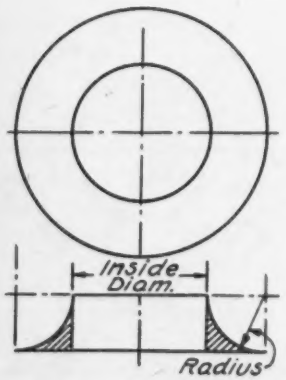
By W. L. Tryon



To find the weight of a fillet of any length multiply the weight per inch, obtained from the table on Data Sheet No. 274, by the length.



To find the weight of an inside circular fillet, first find the circumference of a circle whose diameter is the outside diameter minus 0.45 of the radius. Then the weight required is this circumference multiplied by the weight per inch obtained from table on Data Sheet No. 274.



To find the weight of an outside circular fillet, first find the circumference of a circle whose diameter is the inside diameter plus 0.45 of the radius. Then the weight required is this circumference multiplied by the weight per inch obtained from table on Data Sheet No. 274.

WEIGHT OF FILLETS

By W. L. Tryon

Table for Computing Weight of Fillets

For Method of Application, see Data Sheet No. 273.

Rad. in in.	Weight of Fillet 1 Inch Long When Cast in: Cast iron	Steel	Alumi-num	Cop-per	Zinc	Gun metal	Yellow brass
¼	.0035	.0038	.0013	.0043	.0034	.0043	.0041
⅜	.0079	.0086	.0029	.0097	.0077	.0095	.0091
½	.0140	.0152	.0052	.0172	.0136	.0170	.0163
⅝	.0219	.0238	.0081	.0266	.0222	.0265	.0254
¾	.0315	.0342	.0116	.0386	.0307	.0381	.0367
⅞	.0440	.0466	.0158	.0526	.0416	.0520	.0498
1	.0559	.0612	.0207	.0688	.0543	.0679	.0652
1⅛	.0710	.0772	.0262	.0871	.0688	.0857	.0823
1¼	.0876	.0954	.0322	.107	.0850	.106	.102
1⅜	.106	.115	.0390	.130	.103	.128	.123
1½	.126	.137	.0465	.155	.122	.153	.147
1⅝	.148	.162	.0545	.181	.143	.179	.172
1¾	.174	.186	.0634	.211	.166	.208	.200
1⅞	.197	.214	.0726	.242	.191	.239	.229
2	.224	.244	.0826	.274	.217	.271	.260
2⅛	.253	.276	.0935	.310	.245	.304	.293
2¼	.285	.310	.105	.349	.274	.342	.328
2⅜	.325	.346	.117	.389	.307	.384	.367
2½	.351	.383	.126	.430	.340	.425	.405
2⅝	.386	.423	.142	.474	.376	.468	.449
2¾	.425	.464	.156	.520	.412	.512	.493
2⅞	.463	.505	.171	.568	.450	.558	.537
3	.504	.550	.186	.620	.488	.612	.586
3⅛	.548	.597	.202	.672	.531	.662	.635
3¼	.592	.645	.218	.726	.573	.715	.687
3⅜	.638	.694	.236	.784	.620	.772	.742
3½	.686	.747	.254	.841	.666	.830	.797
3⅝	.737	.800	.272	.905	.715	.890	.855
3¾	.789	.857	.289	.968	.765	.954	.915
3⅞	.841	.916	.312	1.03	.815	1.02	.977
4	.896	.978	.330	1.10	.868	1.08	1.04
4⅛	.944	1.04	.352	1.17	.922	1.15	1.11
4¼	1.01	1.10	.374	1.24	.980	1.22	1.17
4⅜	1.07	1.16	.396	1.31	1.04	1.30	1.25
4½	1.14	1.23	.418	1.39	1.10	1.37	1.32

Rad. in in.	Weight of Fillet 1 Inch Long When Cast in: Cast iron	Steel	Alumi-num	Cop-per	Zinc	Gun metal	Yellow brass
4⅝	1.20	1.30	.442	1.47	1.16	1.45	1.39
4¾	1.26	1.37	.467	1.55	1.23	1.53	1.47
4⅞	1.33	1.44	.492	1.63	1.29	1.61	1.55
5	1.40	1.52	.516	1.72	1.36	1.70	1.63
5⅛	1.47	1.60	.544	1.80	1.43	1.78	1.71
5¼	1.54	1.68	.568	1.89	1.50	1.87	1.79
5⅜	1.62	1.76	.598	1.98	1.57	1.96	1.88
5½	1.70	1.84	.626	2.08	1.64	2.05	1.97
5⅝	1.78	1.93	.643	2.17	1.72	2.14	2.06
5¾	1.86	2.02	.682	2.27	1.80	2.24	2.15
5⅞	1.94	2.11	.713	2.37	1.88	2.34	2.24
6	2.02	2.20	.742	2.47	1.96	2.44	2.34
6⅛	2.10	2.29	.773	2.58	2.04	2.54	2.44
6¼	2.19	2.38	.805	2.68	2.12	2.65	2.54
6⅜	2.28	2.47	.838	2.79	2.21	2.75	2.65
6½	2.37	2.57	.874	2.90	2.30	2.86	2.75
6⅝	2.46	2.67	.906	3.02	2.38	2.97	2.85
6¾	2.55	2.78	.942	3.13	2.47	3.08	2.96
6⅞	2.65	2.89	.975	3.25	2.56	3.20	3.07
7	2.75	2.99	1.01	3.37	2.66	3.32	3.18
7⅛	2.84	3.10	1.05	3.50	2.75	3.44	3.29
7¼	2.94	3.21	1.09	3.62	2.85	3.56	3.42
7⅜	3.04	3.32	1.12	3.74	2.96	3.68	3.54
7½	3.15	3.43	1.16	3.86	3.06	3.82	3.66
7⅝	3.26	3.54	1.20	3.99	3.16	3.94	3.78
7¾	3.37	3.66	1.24	4.12	3.26	4.07	3.91
7⅞	3.48	3.78	1.28	4.26	3.37	4.20	4.03
8	3.59	3.91	1.32	4.38	3.48	4.34	4.17
8⅛	3.70	4.03	1.36	4.53	3.59	4.48	4.30
8¼	3.82	4.16	1.41	4.68	3.70	4.62	4.43
8⅜	3.93	4.28	1.45	4.81	3.81	4.76	4.57
8½	4.05	4.40	1.50	4.95	3.92	4.90	4.71
8⅝	4.17	4.53	1.54	5.10	4.04	5.04	4.84
8¾	4.29	4.67	1.58	5.26	4.16	5.19	4.98
8⅞	4.42	4.81	1.63	5.42	4.28	5.34	5.12

material. This constant, representing the ratio of stress to strain, is observed by experiment to be nearly constant for all steel no matter what the composition or heat treatment. The value is approximately 29,000,000 pounds per square inch. For malleable it is also 29,000,000 for loads up to about 25,000 pounds per square inch but decreases and is only about 16,000,000 on the curve shown in Fig. 14 at the elastic limit.

Fig. 12 shows the behavior of the three materials in cross-bending and compression. The three upper bars were all loaded at the center to 1000 pounds, the span being 12 inches. The calculation of the ultimate fiber stress to which the three bars were subjected is, perhaps, unnecessary in the present connection, the purpose of the exhibit being primarily illustrative. The illustration does not indicate that the three bars are of different widths. As a matter of fact the malleable bar is 1 inch wide, the gray iron bar 0.97 inch wide and the steel bar 0.80 inch wide. It is evident, therefore, that the malleable is slightly weaker than the gray iron and only 0.8 as strong as the steel bar of equal thickness. The gray iron bar, however, broke without any perceptible bend, the malleable bar has merely begun to tear in the lower surface and is not in two distinct pieces and the steel bar does not yet show any rupture but would not have stood a greater load. However, it could have been bent considerably more before breaking had the stroke of the machine been sufficient.

Compression Strains

On the shelf at the bottom of the board are shown samples indicating the effect of compression strains on the three materials. All of these samples were originally ½-inch in diameter and 1 inch high. The three pieces to the left were loaded to 21,000 pounds. The one at the extreme left is steel, and has settled somewhat; the next one is malleable and has settled somewhat more and the third one is gray iron and is so badly shattered that it has to be preserved in a glass tube.

The next sample is a malleable piece which has been loaded to 23,000 pounds and has sheared through but not yet separated into two pieces. The piece at the right is steel, which was loaded to 100,000 pounds, the capacity of the machine, and has merely spread out into a pan cake.

Primarily it is to be observed on this board that the steel and malleable bars deform perceptibly before they are actually destroyed so that articles made of these materials will not break without previous warning.

In addition to the static tests such as have been reported in connection with the samples previously shown, the properties of a material under shock are of considerable importance. These properties are not so easily illustrated as the preceding. There are two kinds of dynamic or shock stresses of interest in this connection. One of these is the effect of repeated small stresses in opposite directions and the other is the resistance to heavy blows. For the former, little data are available and no samples. It is known, however, that malleable iron on account of its micro structure resists alternating stresses of this kind. For the purpose of measuring the latter effect a number of tests have been devised. That which is usually applied to malleable iron is the one commonly attributed to the late J. B. Walker of the Erie Malleable Iron Co., Erie, Pa. It consists in striking the point of a wedge of standard form a series of 70 foot-pound blows until the material breaks, or until 20 blows have been struck. The reader is quite probably already sufficiently familiar with this test.

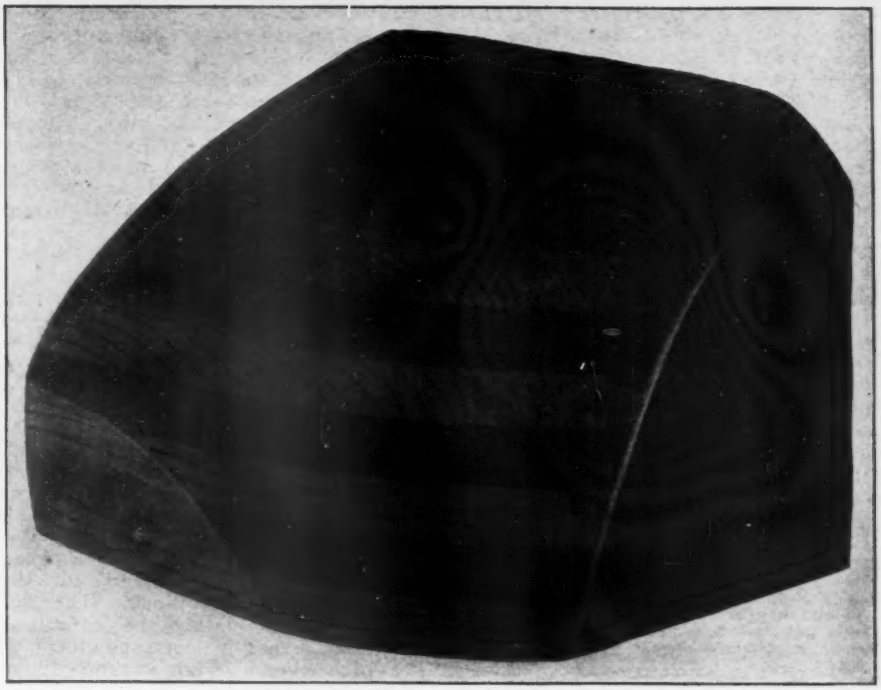


FIG. 16—MODEL ILLUSTRATING EFFECT OF VARYING PROPORTIONS OF SILICON AND CARBON ON STRENGTH OF MALLEABLE IRON

At the bottom of Fig. 13 are shown three such wedges after test. Reading from left to right these are: Steel, malleable and gray iron. The steel and malleable wedges have both been struck 20 blows and have completely curled up. The gray iron wedge has been broken off at the point by the first blow. Measurements of this kind have not yet reached the point where they are quantitatively reliable but the samples here shown will serve to indicate what may be expected of the material.

Of late malleable iron is finding considerable application in the manufacture of iron parts for electrical apparatus, notably field frames for the smaller sizes of motors and generators. Accordingly it is of importance to know the electro magnetic properties of malleable.

The company with which the writer is connected has dealt with this subject thoroughly in a magnetic and electrical laboratory of its own.

Magnetic Properties of Malleable

The magnetic properties of malleable iron are good when the material is of good quality; these properties are comparable to soft steel and are exceeded to an important degree only by absolutely pure iron. On the upper part of Fig. 13 will be found three paper circles indicating the cross-sections of steel, malleable iron and gray iron as marked, which will carry equal magnetic flux at saturation; in other words, a cross-section of each of the three materials of the size indicated by these circles, if magnetized to the utmost limit that the material will permit will have the same strength as a magnet for all of the three materials.

It will be seen that the malleable iron requires relatively a small area for this purpose, much less than the gray iron and but slightly greater than the dead soft steel.

Another point of importance in the design of electrical machinery is the matter of permeability, that is the relation between the electrical energy used in the magnet coils and the resulting strength of field. This is of importance in fixing the efficiency of the magnet and the amount of copper required for its windings. The permeability of all materials varies according to the intensity to which they are to be magnetized. Inasmuch as the flux density has to be pretty high in order to avoid excessive weight in the iron parts of electrical machinery for comparison it has been assumed that the density desired is the greatest which can commercially be obtained in cast iron.

The three coils of copper wire shown in Fig. 13 indicate the relative amounts of copper which with equal consumption of electrical energy will magnetize equal cross-sections of steel, malleable and cast iron to this flux density. The outer coil corresponds to the cast iron, the next to malleable and the smallest to steel. It can readily be seen that the amount of copper required for the gray iron is incomparably greater than that for either malleable or steel; as a matter of fact, it is 144 times as much as for steel and between 80 and 90 times as much as for malleable iron. For the benefit of those who may be interested in more exact data, Fig. 15 will indicate

the magnetization curve and hysterisis loop of malleable iron of suitable quality for magnetic purposes.

The spiral chip which encircles the exhibit on the board shown in Fig. 13 is one continuous turning removed from a malleable casting. It is 24 feet long, not including the increased length due to its spiral form and it is presented here as evidence of the machining qualities of the material.

The figures here quoted are derived from a considerable number of tests and observations which have come to the writer's attention and err if anything on the side of conservatism. They may be taken as entirely safe for the basis of any engineering design when the material is obtained from reputable manufacturers.

The figures are as follows:

*Tensile strength, pounds per square inch.	45,000
*Elongation, per cent	7½
*Ultimate fiber stress in cross-bending, pounds per square inch	84,000
Young's Modulus, for loads under 25,000 pounds per square inch	29,000,000
Elastic limit, pounds per square inch	35,000
Strength in compression, pounds per square inch	100,000
Specific gravity	7.4
Intensity of magnetization at saturation, C. G. S. units	11,500
Permeability at this density, C. G. S. units	300
Maximum permeability (at about 6000 lines per square centimeter)	2,000

*Based on A. S. T. M. specifications.

It is unfortunate that almost everyone expects to ask: What is the tensile strength of malleable iron, or the permeability, or whatever else may be under discussion, without an adequate understanding of the fact that malleable iron has been made of a great variety of compositions and anneals, many of them not suited to good work. Even eliminating the variations of compositions and heat treatment due to ignorance alone or to unexpected accidents, and not in accord with good practice, there remains the question of adapting the material furnished to the conditions required.

Variations in Properties

The properties of malleable iron vary considerably according to the quantities of carbon and silicon which it contains and it is perfectly legitimate to select carbons and silicons which in the judgement of the manufacturer are adapted to the best interests of the customer and which depend on his individual requirements. It is fortunately true that the requirements of most customers can be met by a fairly standardized product. There are, however, particular instances where owing to the peculiarities of individual requirements some advantages must be sacrificed. Thus, for instance, great strength is not compatible with small work or intricate designs. Great perfection of surface frequently necessitates a sacrifice in physical properties and so on. The metallurgical details of this matter need not be fully entered upon in this connection; suffice it to say that variations of strength attend variations of chemical composition and that it is the part of a skillful manufacturer of a product to maintain his chemical composition appropriate to the work he is required to furnish.

A high carbon product is necessarily weaker than a low-carbon product. Under certain circumstances silicon also has its effect in decreasing the strength of the material. The user might not and, indeed, should not be interested in the chemical specifications of the product furnished him but should depend upon a statement of the properties he requires in securing a product suitable to his needs.

In Fig. 16 is shown a model which will illustrate qualitatively the changes of strength with varying compostions of iron. In this figure the dimension of the base running upward to the left indicates variations of silicon. The dimension running upward to the right indicates variations of carbon and the strata shown in the block indicate the tensile strength of metal of the corresponding compositions. The block represents in its entirety the whole range in which malleable may well be made. The regions in which the well informed foundrymen operate are toward the rear corner of this block. The figure will show plainly the enormous drop in strength corresponding to the high silicon, high carbon alloys at the near corner of the figure.

Manufacturing Methods Sound

There remains now for consideration the question whether or not the manufacturers of malleable iron merit the confidence of the consuming interests in the soundness of their manufacturing methods. This question is, of course, not capable of a general answer for in this as in other lines of manufacture there may be careful and careless producers; there may exist knowledge or ignorance; skill or crudeness.

This prompts the question: What steps do the reputable manufacturers take to safeguard the interests of customers? In the early stages of the art, through ignorance much was left to chance even in the best conducted establishments. In each plant there grew up a small group of men who developed an almost uncanny ability to guess right and upon their guesses depended the quality of the product. These men based their guesses not on any definitely known principles but merely upon an extremely well educated power of observation and a long memory; like Providence they "moved in mysterious ways their wonders to perform," all undaunted by their profound ignorance of any metallurgical principles or even of the fact that there was such a thing as practical scientific metallurgy.

The well conducted establishment today avails itself of the services of a trained metallurgist either as a consultant or within its own organization. It sets up a system of chemical control designed to inform it of the composition of all its raw material and its product at appropriate stages of manufacture. It supervises its annealing operations by the highest type of autographic pyrometers. It maintains research facilities by which its metallurgists may inform themselves as to causes of failure and in which experimental work in pure science can be done which has bearing on any of the problems of the industry and it calls into consultation such experts in chemistry and physics as may be required to supplement the knowledge of its own staff.

Many writers, notably Enrique Touceda, have pointed from time to time to the fact that but a few years ago much malleable was sold with a tensile strength far below 40,000 pounds per square inch and have pointed to the consistent improvement to the present 45,000 pounds, with 7½ per cent elongation which is now generally exceeded very considerably.

Mr. Touceda's figures are avowedly representative as nearly as possible of the malleable industry as a whole and not of any particular plant. In 1903 there was established under the writer's supervision the first chemical laboratory operated by a malleable foundry. About two years were consumed perfecting the methods, and organization and in focusing attention upon the proper points. In this laboratory there are at hand analyses and tests of each heat made in the past 13 years—about 50,000 or 60,000 in all. In that time the records do not show any interval in which the product averaged as low as 40,000 pounds per square inch. The average for this series was 45,000 and 46,000 pounds per square inch. Elongations are unfortunately not available but it can be said that these results were not accomplished at the expense of that property.

In the last few years continued research has been productive of great improvements in the plants which come under the writer's notice. Turning to the more recent times one corporation was occupied with certain ordnance work at five different plants for a period of about four months. The government specifications were those of the American Society for Testing Materials and in that time not a single heat was condemned at any of the plants for not conforming to specifications either by the government inspectors who conducted the tests or by the company's laboratories.

Purchases New Plants

Two plants recently have been purchased and added to the manufacturing facilities of the Michigan Machine Tool & Foundry Co., Ypsilanti, Mich. These are the machine shop and gray iron foundry of the Michigan Press Co. of the same city and the Plymouth Motor Castings Co., Plymouth, Mich. The latter plant produces gray iron and semisteel castings. Theo. H. Millington, president of the parent company was formerly consulting engineer for the General Motors Corp., and his experience gained in the motor manufacturing field will be applied in producing a new 4-wheel drive tractor.

Commence Operations in New Electric Steel Foundry

Operations were started about Dec. 15 in the new foundry of the Gerlinger Electric Steel Foundry Co., which is chartered by the Gerlinger Steel Castings Co., Milwaukee. This foundry has a capacity of 15 tons of steel castings a day. William E. Gerlinger is president; George P. Gerlinger, vice president, and C. A. Gerlinger, secretary-treasurer.

Saving Time in Making an Exhaust Dome Pattern

A Skeleton Half Pattern Was Quickly Produced, Which Took the Place of a Solid, Complete Model—How the Pattern Was Made and Molded

By L J Gard

INSTANCES often develop where a special pattern of large size is required to repair a breakdown. In such cases the pattern is seldom used again; thus a quickly constructed pattern that can be produced with the minimum amount of expense is generally furnished.

Recently we received a rush order for an exhaust dome pattern for a 5700-square-foot surface condenser, the detail drawing for which are shown in Fig. 1. Ordinarily, a pattern for a casting of this kind involves quite an expense both for labor and material, but in this instance a satisfactory job was quickly turned out by making a skeleton half pattern from which an excellent casting was produced.

A skeleton core box and a skeleton frame, placed in the drag half of the mold while the cope was being rammed, and a skeleton cover-plate pattern were provided. The skeleton frame supported the pattern while in the cope. This had an ample bearing on the flat part of the bottom of the mold. Also, it fitted the sides of the mold snugly for a depth of 4 inches. The object of this was to prevent crushing the edges of the molded drag while ramming the cope.

The skeleton frame is shown on the back of the pattern at *C*, Fig. 2. One end of it also is shown at the back of the pattern in Fig. 3, which is the finished pattern. The flange around the side opening of the pattern is removable, for as shown in Fig. 1, this opening is on one side of the casting only. In molding the side without the opening, the flange was removed and the opening *A* Fig. 3, in the main section of the pattern was filled with the board shown at *B*, Fig. 2. This was the only change necessary to adapt the pattern for molding both sides of the casting. The flange was easily removed as it was held in position by dowel pins.

The back of the pattern is shown at *C*, Fig. 2; *A* is the skeleton core box and *D* and *E* front and back views of the cover plate pattern. In the finished exhaust head, this cover fits over the opening *A*, in Fig. 3.

The pattern work, with few exceptions, was done by methods known to every patternmaker. In making the circular cores shown at the right and left of Fig. 3, however, the method followed was a departure from general practice and it saved both stock and labor.

It was necessary to provide one head only as this was cut in half, one-half for each core print. The staves to form the bodies of the prints were first glued and nailed around the head and then the parting joint was fitted. Next, the two half heads were placed together and mounted on the lathe face plate. Two circles of soft iron wire were placed around the staves and the ends twisted to draw the wires tight. As there was no head at the outer end of the staves it was necessary, of course, to provide means for securely holding the staves in position during the turning operation and the wires served this purpose admirably.

A shoulder at the outer end was first turned. This was to fit the flange, shown plainly in Fig. 3. After the shoulder was finished, the wires were relocated in this place and the remainder of the prints turned.

The flange, which was made of segments securely tongued and glued together, was next glued and nailed in position and finished by turning. Before finishing the flange, strips were fastened across the parting joints on the inside of the staves to hold the two prints together while the flange was turned to size. Thus, each flange and print was made integral, and each was fastened in place on the pattern by means of screws through the flanged portion. By this method, the prints were produced at a minimum expense, but at the same time they were amply strong enough for all practical purposes.

The molder used the pattern in the following manner: The drag was molded first, and after it was rammed it was rolled over and the pattern drawn. Then the skeleton frame was placed in position in the drag, the change made in the pattern for the side opening, the half pattern placed in position on the frame and the cope rammed. Next, the cope was drawn, the pattern and the frame taken out and the cores set in the usual way.

In making the mold for the cover plate shown at *D* and *E*, Fig. 2, it was only necessary to fill the open spaces with sand and strike off level with the strips to get a solid pattern, after which the mold was made in the usual way.

The foundry where the casting was made was some distance from our local-

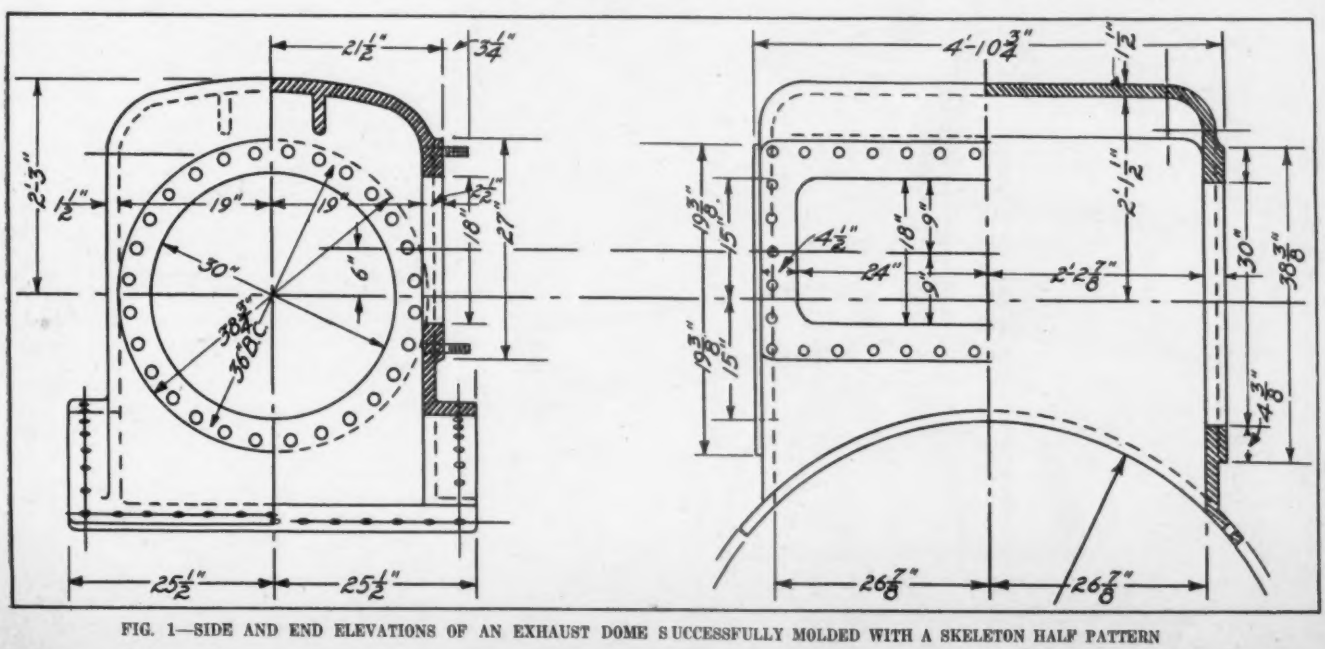


FIG. 1—SIDE AND END ELEVATIONS OF AN EXHAUST DOME SUCCESSFULLY MOLDED WITH A SKELETON HALF PATTERN

ity. Otherwise we should have made a flask board and provided for doweling the half pattern centrally in position. If this were done, both the drag and the cope could have been rammed on the flask board with the pattern in the same position for each, according to present-day molding machine practice.

Magnesium as a Deoxidizer for Brass and Bronze

Magnesium has a strong affinity for oxygen and a very high combustion temperature; that is, it combines readily with oxygen and in burning develops intense heat. An example of the affinity or attraction that magnesium has for oxygen is illustrated in the case of water. Magnesium will decompose boiling water, forming magnesium oxide and liberating hydrogen. In the same way, magnesium at the temperature of molten brass or bronze will decompose the oxides of copper or other metals as well as the gases, such as carbon monoxide, or carbon dioxide, in the molten metal.

The effect of deoxidizing bronze is to produce a stronger and denser metal, eliminating porosity when it is due to oxygen, either existing free or as oxides. The metal will be finer-grained, but its machining qualities will not be altered if the proportion of magnesium is so adjusted that all the oxides are entirely eliminated. The proper proportions in which magnesium is used in brass, or bronze will vary a little, but it must be kept low to get good results, and should not exceed 0.10 per cent, although one-half of this amount is usually sufficient. This means that 1 pound of magnesium will deoxidize from 1000 pounds of brass or bronze. At its present price of $2 per pound, the cost of mangnesium as a deoxidizing agent is infinitesimal compared to the total.

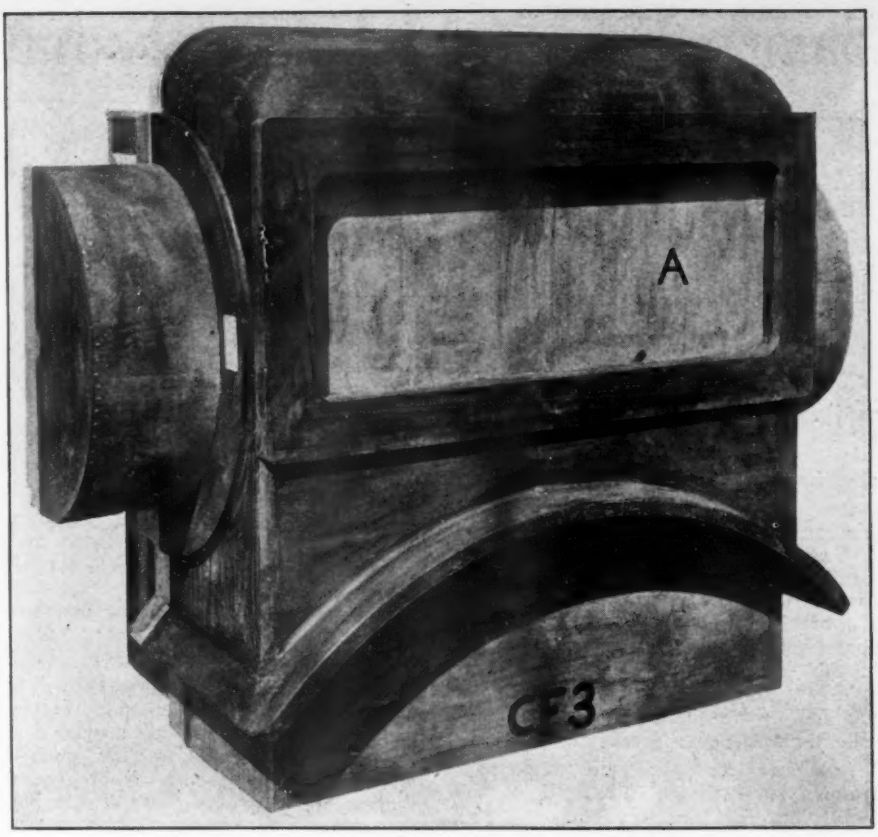


FIG. 3—THE COMPLETE PATTERN WITH SKELETON FRAME ATTACHED AT BACK

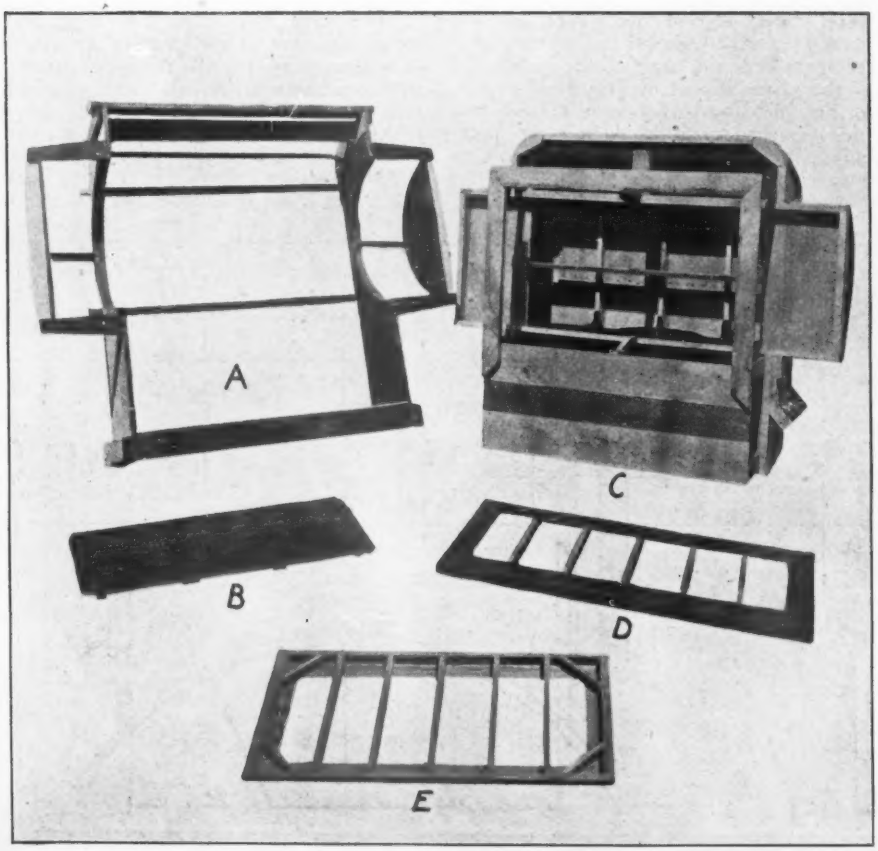


FIG. 2—SKELETON CONSTRUCTION WAS USED TO SAVE STOCK AND THE PATTERNMAKER'S TIME

Magnesium can be added to molten metals in the metallic form. In this case it is dropped onto the surface of the metal and is incorporated with it with a graphite stirrer. However, as the amount of magnesium that should be added to brass or bronze is small, it is recommended that the addition be made in the form of 10 per cent magnesium copper. This alloy is made by melting copper under a cover of magnesia then adding stick magnesium in the proportions required. The magnesium is thrown onto the surface of the copper and is mixed with a graphite stirrer. The loss by melting is small as the magnesium readily forms the alloy. One-half pound of this alloy will add 0.5 per cent magnesium.

Magnesium has been used in brass foundry practice for 10 or 15 years. Formerly it was considered necessary to immerse the magnesium in the metal, plunging it to the bottom of the crucible with a small phosphorizer. Tongs also were used for plunging the magnesium to the bottom of the metal. This method has several disadvantages, however; the tongs soon were ruined from the metal running into the hinge and solidifying; also, if the tongs were damp, an explosion followed. Furthermore, iron was dissolved in the metal from the tongs as it was fused off the jaws.

It is always advisable to first make the magnesium-copper alloy. This is dropped into the metal and the bath is stirred to thoroughly incorporate the alloy. After the magnesium has been added, quickly remove the alloy and pour into closed molds to prevent loss. The Shawingan Electro-Metals Co., Leader-News building, Cleveland, specializes in magnesium for general brass foundry purposes.

Converted Plow Plant Makes Efficient Foundry

Natural Obstacles and Limited Space Both Are Turned to Assets in the Layout of a Foundry Producing Agricultural Castings in Quantity

PRODUCING castings for a manufacturing plant as large as that of the Avery Co., Peoria, Ill., is no small undertaking. Last year's output of this establishment included approximately 9000 tractors, 15,000 grain separators, 1000 motor cultivators, besides numerous plows and sundry lighter farming equipment. To supply this enormous demand for steel, gray iron and semisteel castings would seem almost impossible from a molding floor which is roughly 80 x 450 feet. But intelligent arrangement, coupled with a diligent and fruitful search for "the one best way" has solved the problem. Lack of space, normally a detriment, in this case has been converted into an asset. That which ordinarily would be considered limited working room operates to bring within the workman's ready reach the equipment and materials which he most desires.

It should not be inferred from these statements that the Avery foundry is crowded or in any way congested. Few casting plants exhibit the system and order which characterize this shop, and the accompanying illustrations indicate that every inch of space is utilized and forced to produce its maximum of castings.

That which has served to make each natural feature an advantage in the layout of this foundry is the broad engineering experience and ability of those in executive charge. Each natural obstacle in the conversion of a former plow factory into an efficient foundry for quantity production has been merely a problem to be met. And each problem has been attacked with a belief in the power of the formula "it can be done."

The Foundry Layout

Natural topographical features which characterize the banks of the Illinois river at Peoria have aided to make the arrangement of the Avery foundries unique in the application of progressive operations through the plant. A series of buildings purchased from the Kingman Plow Co., in 1916, provided the nucleus for the foundry layout. These buildings were placed longitudinally with the direction of the river. Spur tracks were built along the uphill side of the group as well as along the river bank. The sectional plan, Fig. 2, illustrates the stair-step arrangement which was developed. To the engineers who adapted this plant to foundry purposes, the natural downward slope of the embankment proved the incentive to utilize the natural force of gravity in conveying the work through the plant. Accordingly, the raw materials are unloaded on the uphill side into storage bins and from that point travel transversely through the cupolas, and furnace, across the molding floors, the mill room and chipping room to the scales and finally to the cars. At present, the equipment for machining is being removed from the main Avery plant, about a mile down the river, to a building directly along the river bank, so that in the near future, instead of conveying the rough castings to the machine shop and then returning the machine scrap, the finished castings will leave the plant direct and the scrap can be returned by the interplant conveying equipment to the melting floors.

The progress of gray iron and steel castings through the foundry is parallel. Scrap, pig iron and coke, all are unloaded on the uphill side, as previously stated. The light scrap is assorted and placed in bins according to size and composition. Along the front of these bins runs a narrow gage trackway with frequent turntables connecting with transverse trackways which in turn run out into the scrap storage yard. A monorail craneway circles this yard. In the yard, pig iron and heavy scrap are loaded into the charging cars. In the near future an 80-foot, 20-ton girder crane will be installed which will run at such an angle across the storage yard, that the materials may be handled and loaded into the charging cars by an electric magnet. This crane has been purchased from the Shaw Electric Crane Co., Muskegon, Mich. Fig. I shows its location

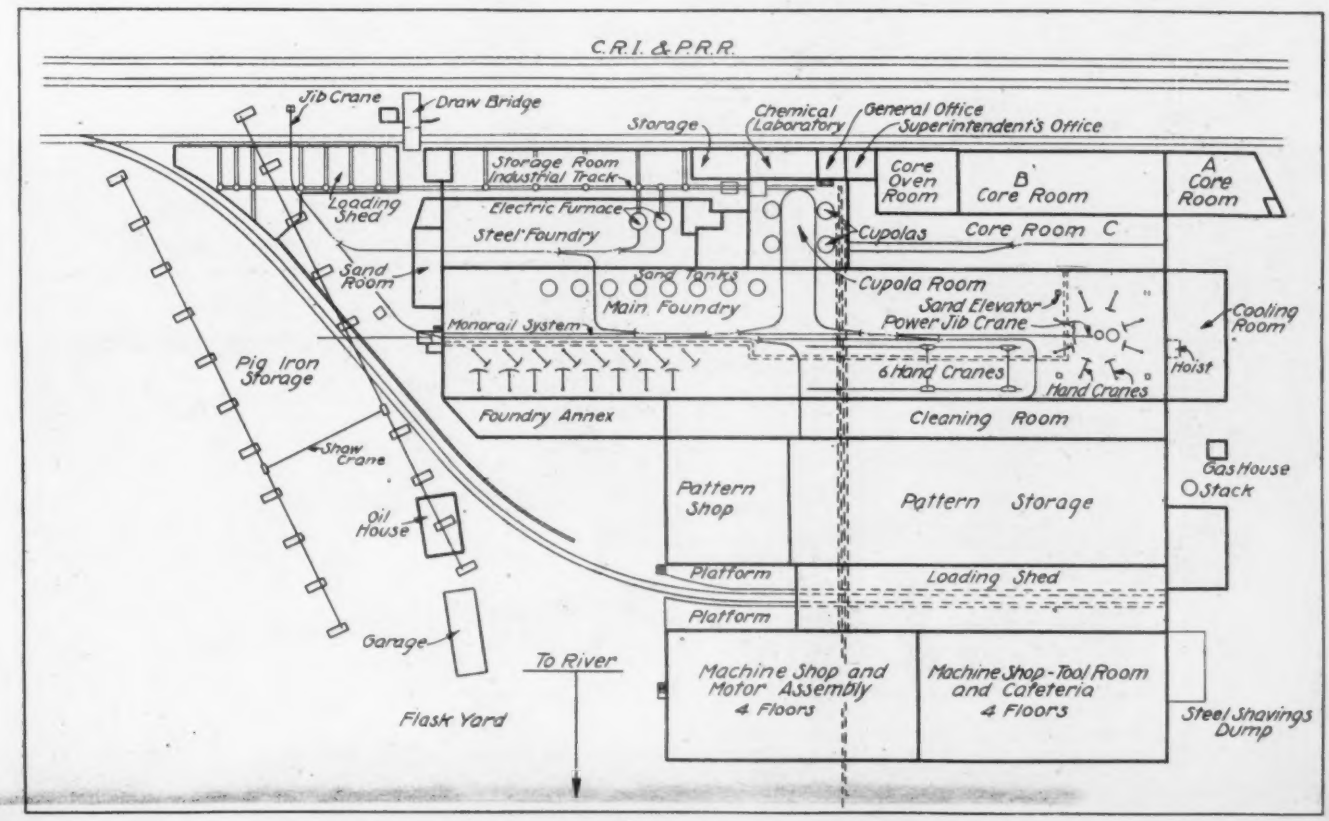


FIG. 1—GROUND PLAN OF THE FOUNDRY OF THE AVERY CO., PEORIA, ILL., SHOWING THE WAY IN WHICH EXISTING BUILDING ARRANGEMENT WAS USED IN THE CONVERSION OF A PLOW FACTORY

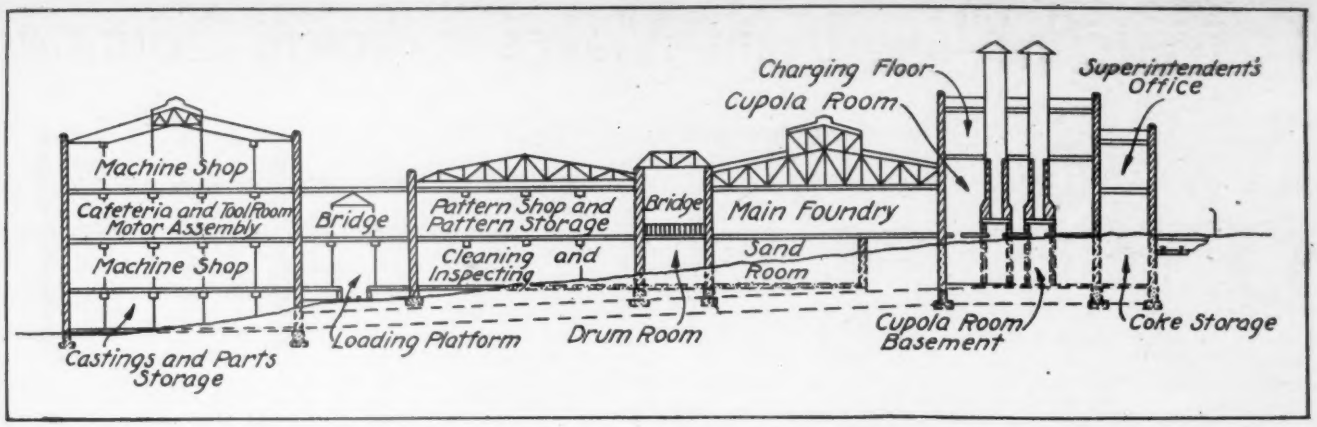


FIG. 2—SECTIONAL VIEW OF THE FOUNDRY DEPARTMENTS, WHICH ARE TIED TOGETHER IN SUCH A MANNER AS TO BE PRACTICALLY A UNIT NOTE THE ADVANTAGE TAKEN OF THE NATURAL GROUND SLOPE

An indication of the thoroughness with which each detail that might delay production is obviated, is furnished by the fact that 100 charging cars are provided to handle the raw material to the single electric furnace and the four cupolas, two of which are in operation each day. The main trackway which parallels the storage bins for light scrap runs directly over a beam scale to an elevator at the corner of the cupola building. This elevator, a 5000-pound electric passenger type lift, built by the Otis Elevator Co., runs from the basement beneath the cupola building to the charging floor which is 25 feet above the main cupola floor. The installation of this high speed elevator to handle foundry materials again is indicative of the engineering skill which strives to prevent every possible element of delay.

Handling and Charging

The coke is unloaded into an 8-foot basement adjoining the cupola room. This storage room has a capacity of 10 cars. The coke is loaded into cars in the basement, rolled to the elevator at the corner nearest the cupola room above and hoisted to the charging floor.

The charging floor is ventilated on four sides and is kept exceptionally clean. Two men on this floor handle all the material for the four cupolas.

The appeal of the war industries board to economize on pig iron met with ready response from the Avery Co. At present, the cupola charges for both gray iron and semisteel never carry over 30 per cent of pig iron. The semisteel mixture which is used for all gear castings, contains 20 per cent steel scrap, while 5 per cent of steel scrap is used in the gray iron mixture. A typical gray iron charge is made up of 15 per cent of low phosphorus pig iron; 35 per cent of shop scrap, consisting of

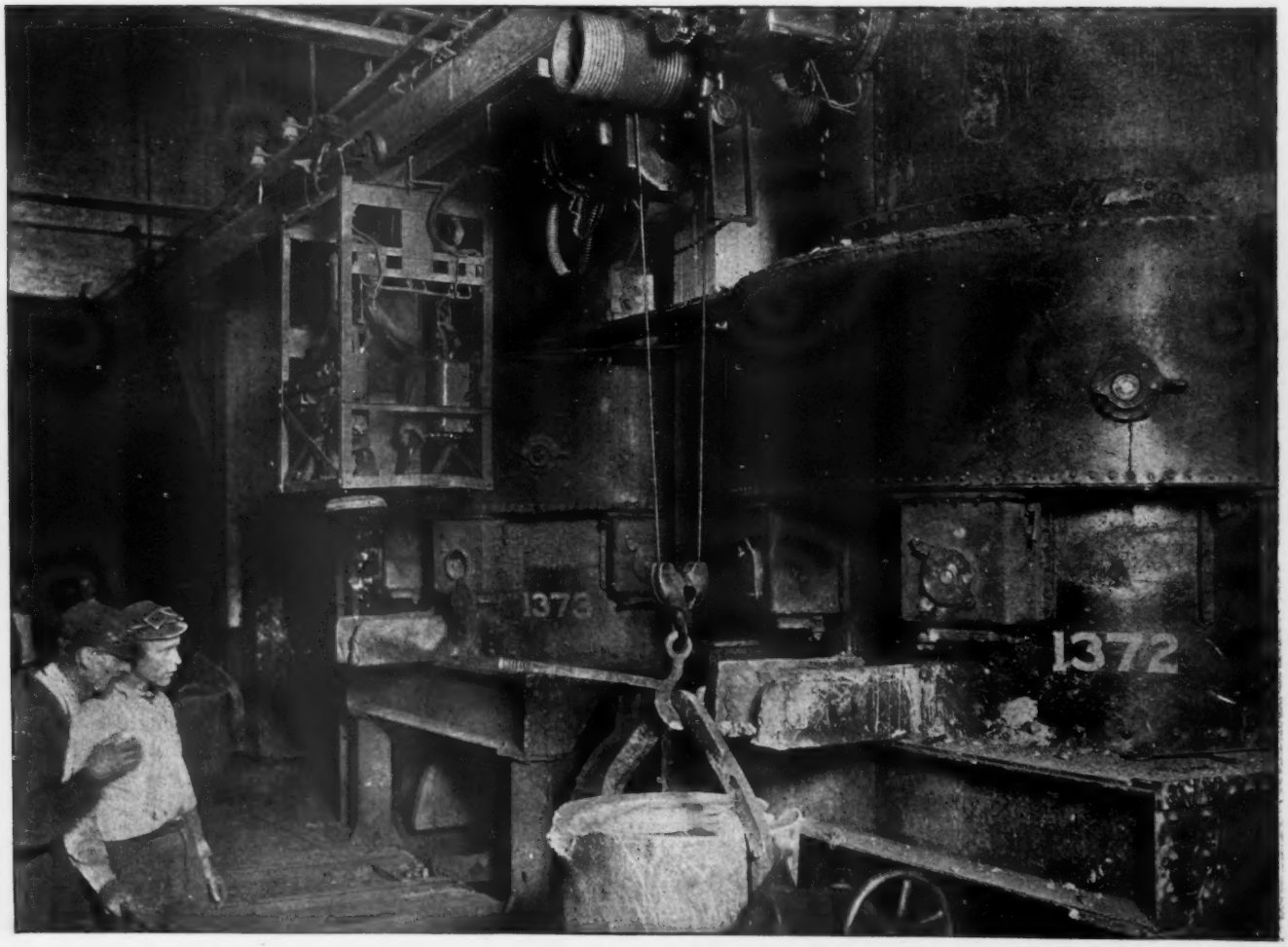


FIG. 3—TWO OF THE BATTERY OF FOUR CUPOLAS LOCATED IN A ROOM ADJACENT TO, BUT SEPARATED FROM THE MAIN MOLDING FLOOR—NOTE THE MONORAIL WHICH DELIVERS THE LADLES, AND THE PIT CONNECTING WITH THE MAIN TUNNEL

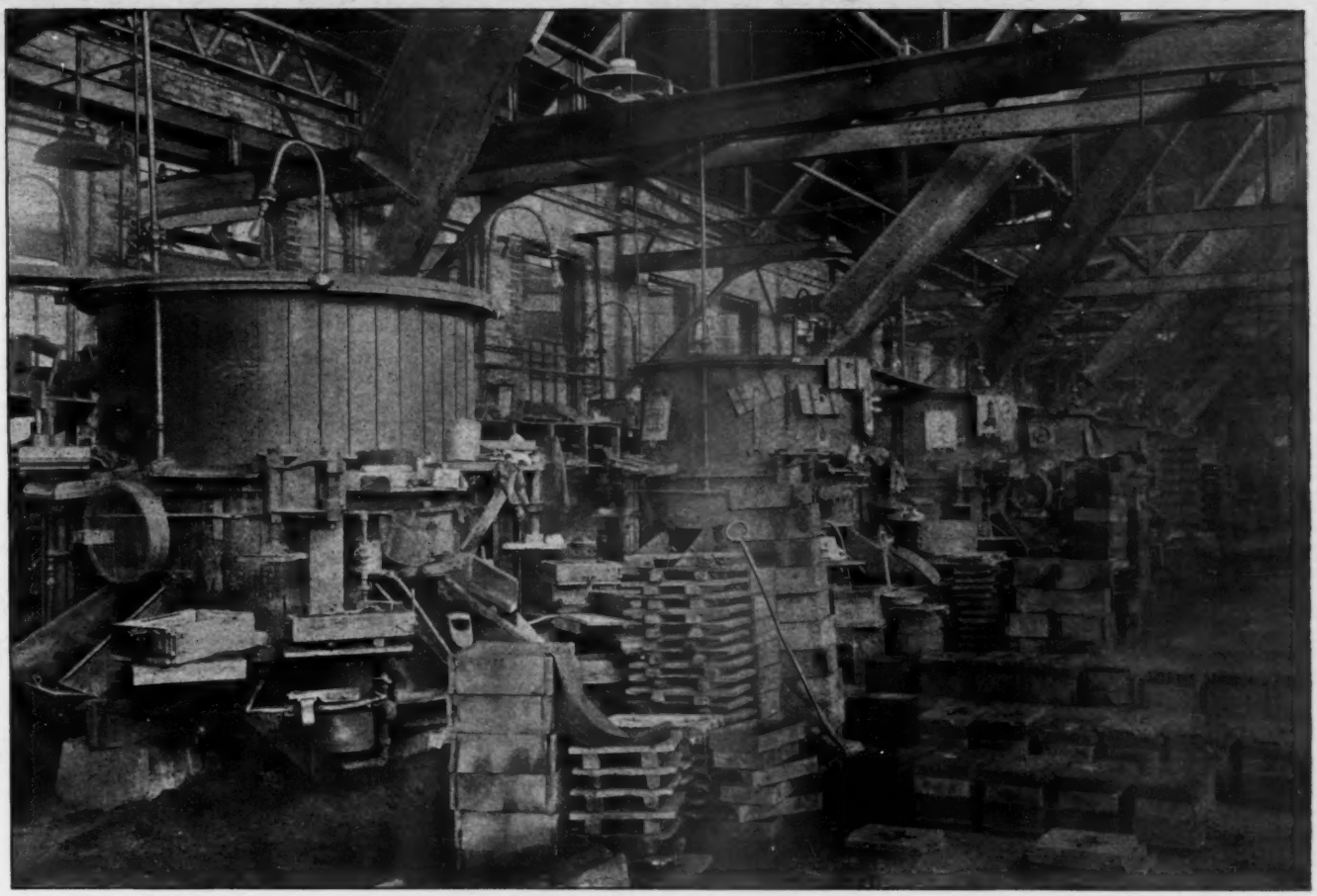


FIG. 4—EIGHT SAND TANKS, EACH WITH FOUR SMALL SQUEEZERS FORM THE UNITS ABOUT WHICH THE SMALL MOLDS ARE MADE—THE CHUTES CARRY THE SAND FROM BUCKET ELEVATORS OVERHEAD

FIG. 5—SECTION OF THE MOLDING FLOOR DEVOTED TO THE MEDIUM SIZED CASTINGS—TEN FLASKS ONLY ARE REQUIRED AT EACH MOLDING STATION AS THE OPERATION IS PRACTICALLY CONTINUOUS

gates and risers, chippings and defective castings and 50 per cent of machine shop cast scrap. All foundry scrap is tumbled to remove the sand. To the total charge is added about 7 pounds of 50 per cent ferrosilicon per 1000 pounds of iron and 5 pounds of spiegeleisen per 1000 pounds of iron, both of which are added in the cupola. The tensile strength developed by this mixture averages from 27,000 to 30,000 pounds per square inch and 15 to 18 per cent deflection. Chemical control of each heat is exercised by a chemical laboratory located adjacent to the cupola room on an intermediate floor.

Precedent was disregarded in the arrangement of the cupola room. Instead of establishing a row of cupolas along the side of the main foundry floor, a separate room connected only by a single doorway to the main foundry is utilized. In this

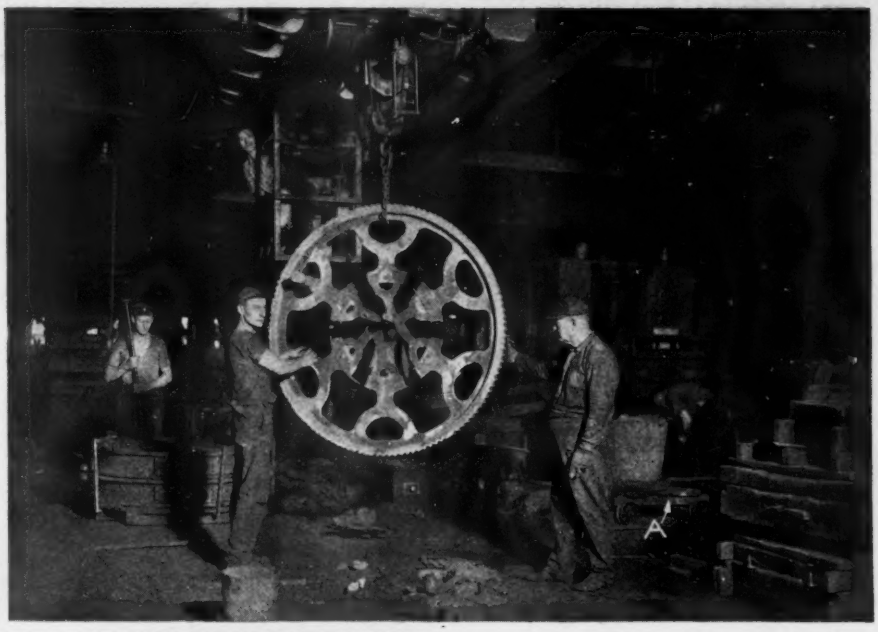


FIG. 6—THE LARGEST CASTING PRODUCED IN THIS FOUNDRY IS SHOWN READY FOR DELIVERY BY THE MONORAIL CRANE TO THE CLEANING FLOOR—NOTE THE LIGHT TRUCKS USED FOR MOLDS SHOWN AT *A*

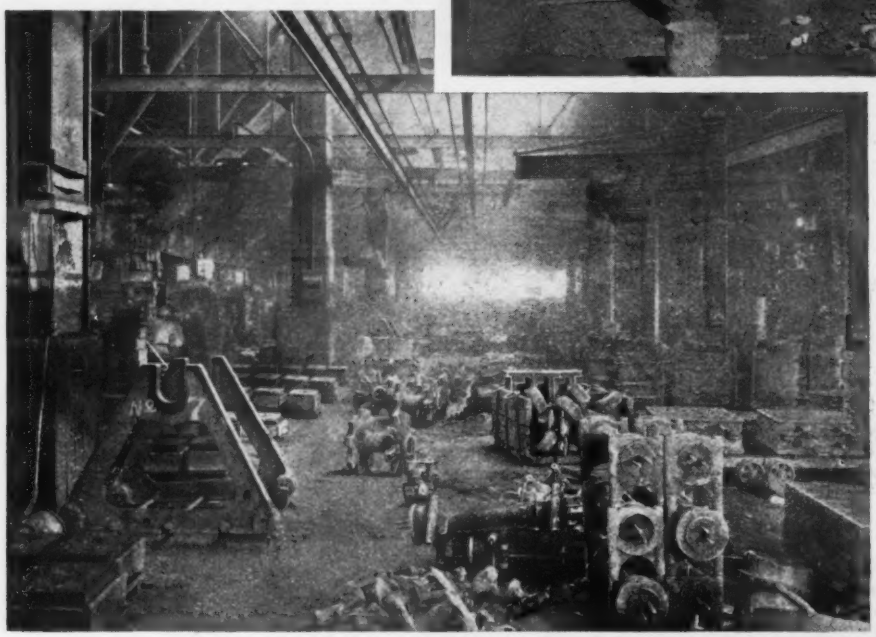


FIG. 7—MAIN AISLE OF THE AVERY GRAY IRON MOLDING FLOOR—THE LADLE STAND AT THE LEFT HOLDS THE LADLES WHILE HAND SHANKS ARE FILLED FOR POURING THE LIGHT CASTINGS

room four cupolas are located, placed in pairs opposite each other on each side of a central aisle along which cars containing foundry scrap are returned to the charging elevator. A monorail trackway circles this room and carries a crane which delivers and returns ladles to any of the four furnaces. A pit beneath each cupola is so arranged that the bottom may be dumped into cars and transported to the river bank through a 1000-foot tunnel which runs under all the foundry buildings. In this way the refuse is removed and dumped to form reclaimed land along the water front. The segregated arrangement of the cupolas prevents the customary distraction and confusion during tapping operations.

At one side of the aisle are two 90-inch cupolas, built by the Whiting Foundry & Equipment Co., Harvey, Ill., which are lined to 72 inches and opposite them are two 66-inch cupolas with 48-inch linings. All the units are served by a single blast line with two pipes leading to opposite sides of the wind box of each cupola. Special butterfly air valves provide minute control on the blast at each of these eight lines. All blast pipes are made of No. 14-gage iron, welded into sections which are bolted together with flanges in order that individual sections may be removed and replaced quickly at any time.

Blast is supplied by a 10,000 cubic-foot blower, direct-connected to a motor which operates at 3600 revolu-

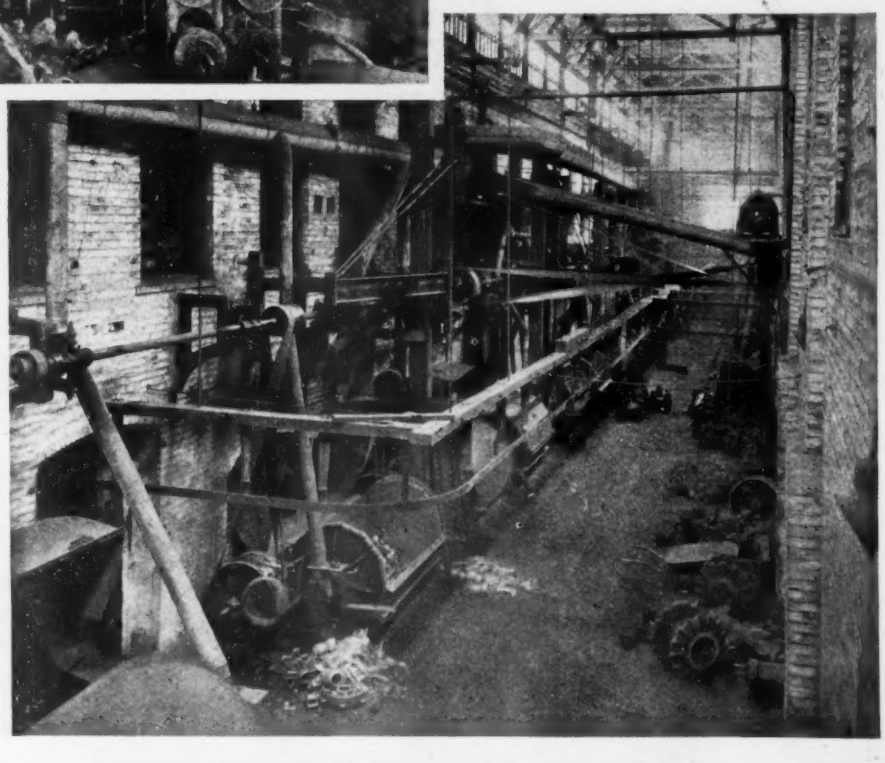


FIG. 8—TUMBLING MILLS ARE ARRANGED IN A ROW ALONG THE SIDE OF A MILL ROOM MADE FROM THE SPACE BETWEEN TWO BUILDINGS—A SUCTION FAN EXHAUST SYSTEM REMOVES THE DUST

tions per minute. This equipment was built by the General Electric Co., Schenectady, N. Y. Air for the pneumatic equipment in the foundry is supplied by a 100-horsepower motor blower equipment furnished by the same company. All blowing apparatus is located in a separate room adjacent to the cupola room. The two transformers are housed in an air-tight vault in the same room. The blast from the cupolas is drawn down into this vault around the transformers and into the blower intakes. This results in a constant current of cooling air about the transformers and prevents heating.

The four melting units provide for alternate operation, one of the larger and one of the smaller cupolas being in service each day alternately with the other two. The larger in each case is used for gray iron and the smaller for semisteel. According to regular schedule provided for the operation of these furnaces the heat is started at 7:30 a. m. and the pouring is carried on continuously until 4:30 p. m. The capacity of both cupolas on this schedule is approximately 110 tons per day including 35 tons of semisteel.

From the cupola room to the foundry floor, transportation is furnished by monorail electric cranes equipped with 2-ton hoists furnished by the Sprague Electric Works of the General Electric Co., New York. There are five of these monorail cranes which serve the entire foundry floor, pick up and move flasks and molds, handle the ladles from the cupolas, lift and carry castings and return the scrap cars to the cupola room. The overhead trackway is provided with switches so that the cranes may be used to run to practically any corner of the entire main floor, as well as into the cupola room and over the storage yard. The switches and all operating parts of the cranes are inspected daily to guard against accidents. Magnets are used to pick up the scrap from the refuse on the shakeout floor and to load this scrap into cars from which it is dumped into the mill room, cleaned in the tumbling barrels and returned in cars to the elevator in the cupola room. The monorail hoists are in use constantly in facilitating this work.

The main foundry floor is on the same level with the cupola room and with the storage bins. The next succeeding division of the plant, the cleaning room is at a lower grade level and occupies the space between two old buildings which has been covered. A basement has been excavated on this level which occupies the entire area beneath the main foundry floor. This, in effect, produces a two-story foundry and adds the force of gravity to the power facilities of the plant. The foundry floor is approximately 80 x 450 feet and is provided with a broad central aisle along the entire length and two side floors where the molding is done. The molding floor is divided into small, medium and large casting departments.

A space about 200 feet along one side is devoted to light castings that are used in tractor construction. To one familiar with the multiplicity of small cast parts in a tractor, the volume of work handled in this section will be apparent. Under ordinary standards of foundry practice, this department would cover a much greater area. Here the best of equipment for quantity production of light castings is grouped.

Along this floor, the company constructed eight cylindrical sand bins or tanks of the type shown in Fig. 4. These tanks are built of wooden staves, set vertically and banded against internal pressure in a manner similar to wooden silos. Prepared and tempered sand is delivered to each of these through chutes. It has been found that the workable qualities of the sand are retained over a greater period of time by this method of storage than is possible with the open floor heaps.

Each of the eight sand tanks constitutes a separate molding unit at which four molders are accommodated and each has a separate pouring floor. Spaced at equal distances around the side of each tank are four

FIG. 9—THE HUB OF THE CASTING SYSTEM DEVOTED TO LARGE CASTINGS—THIS JIB CRANE IS CONSTANTLY ENGAGED IN POURING, SHAKING-OUT, LIFTING THE BOTTOM BOARDS WITH HOT CASTINGS AND LOWERING THEM THROUGH THE OPENING IN THE FLOOR AT *B*

FIG. 10—THE COMPANY-MANAGED CAFETERIA SERVES OVER 500 FOUNDRY EMPLOYES EACH DAY WITH CLEAN, WHOLESOME FOOD

openings about one foot square, with a spout extending outwardly. The bottom of the spout is set at an upward angle from the tank. The sand within the tank falls out by gravity so that each spout is kept constantly filled, but is prevented from spilling over on the foundry floor by the upward inclination of the spout. At the left of each of these four spouts is located an air squeezer upon which the molds are made in snap flasks. A reserve supply of flasks and bottomboards is kept within easy reach of the molders at each of these stations around the tanks. The advantage of the system lies in the fact that the molder has all his materials and equipment directly at hand. Without taking a step he can place a flask on his machine, shovel the sand needed from the spout at his right without stooping or turning, squeeze the drag, roll it over and place it on the rigid stand attached to the machine at his left. He then repeats the same operation in making the cope, closes the mold and lifts it to the molding floor within a few steps of his station. Each molder pours his own work, 32 being employed in the crew that operate at these eight storage tanks.

After pouring, the molds are shaken-out over gratings which allow the sand to drop into the basement, retaining the castings, overflow metal, etc., on the grate. The small castings are thrown into chutes which discharge them across the basement floor into bins located at the side of the cleaning room in the adjacent building. Only the smaller parts are thus delivered as it was found that in dropping the medium and large castings in this manner, the breakage was too great.

The scrap metal is shoveled off the gratings, picked up by magnets attached to the monorail cranes and dropped into small trucks. It is then transported to the tumbling barrels and cleaned before it is returned to the charging floor.

The molds for the medium-size castings, too large for the small snap flasks, are made on a single floor, divided into eight units. The equipment used in each of these eight units consists of a hand-power jib crane at the wall, a pillar jib crane with 1-ton electric hoist at the central aisle, a stripping plate machine under the hand crane, two light trackways at right angles to the main aisle, 10 light cars and 10 sets of steel flasks. The operation of the system is so well timed that the molding is practically continuous, one unit with its 10 flasks being ready for pouring, and shaking-out while the tracks ways of the adjacent one are being filled with new molds. The wall jib crane places the drag flask upon the molding machine, where sand is shoveled from the floor heap under the delivery chutes shown at the right in Fig. 5. After hand-ramming, the pattern is drawn, and the drag is rolled-over by the hand crane and set upon one of the light-frame four-wheeled cars shown in the foreground of the illustration. The cope is handled in a similar manner and the mold is closed. The car with the finished mold is then pushed forward, and additional molds are made until the 10 are finished and grouped on the cars about the pillar crane. One of the monorail cranes operating along the main aisle then delivers a bottom-pour ladle of metal from the cupola room and a pouring gang quickly pours the 10 molds. The electric pillar cranes are utilized to shake-out the molds over gratings in the floor. The flasks and bottomboards are stacked within easy reach of the wall jib cranes, the completed castings are piled along the central aisle for removal to the cleaning room, and the scrap is picked up and removed from the gratings through which the sand has dropped to the basement.

The molding machines used in this section are of the stripping plate type, furnished by Henry E. Pridmore, Chicago. They were especially designed for the Avery Co. and differ from the ordinary machine in the arrangement of a number of individual lugs on the dummy stand to fix the flasks in place. Any one of these lugs may be separately dropped into its slot in the dummy stand if the flask tends to bind when it is removed from the machine. Each machine is placed directly in front of its respective wall jib crane, and the flasks are grouped to the right and left and far enough away to allow the molder to work on all sides of the machine.

The relative positions of the two lines of cranes along the floor devoted to medium castings are indicated in Fig. 1.

The Avery foundry offers an exceptional example of space economy and efficiency in the handling of large castings. The largest casting produced in this foundry is the gear shown in Fig. 6. It is 88 inches in diameter and weighs about 800 pounds. While this is not an unusually large casting, it will be appreciated that in producing a great number of these each day, considerable space ordinarily would be required. The designers of the foundry were faced by the problem of producing a large number of these castings daily and a maximum of 300 per day has been attained. The solution of the problem is unique.

An 18-foot, 2-ton electric pillar crane placed in the center of a floor space approximately 80-feet square, forms the center for this system of operation. Around this crane,

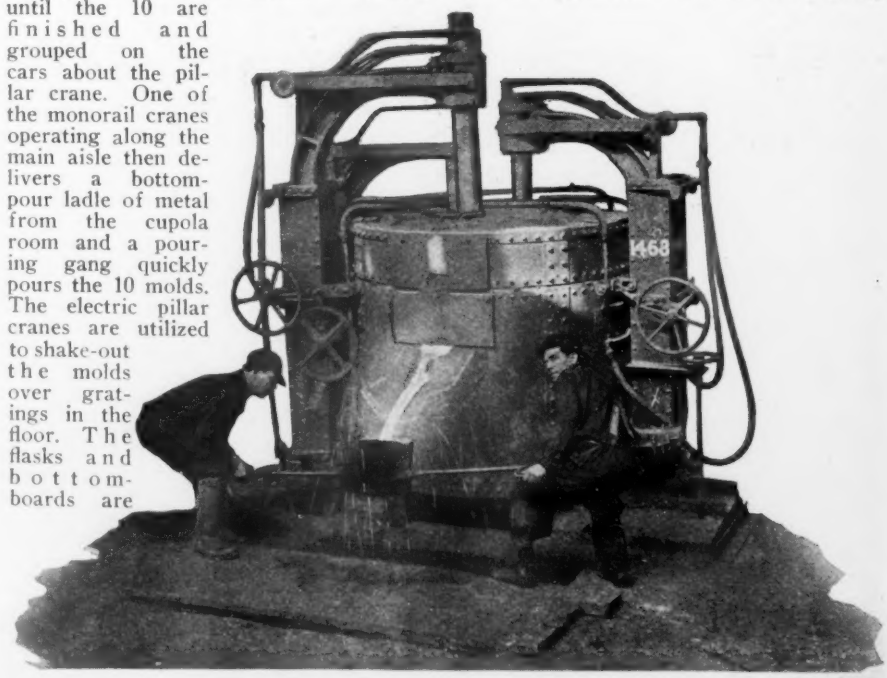


FIG. 11—ABOUT 10 TONS PER DAY OF STEEL PINIONS ARE PRODUCED FROM THIS ELECTRIC FURNACE, WHICH IS OPERATED BY AN ELECTRICIAN INSTEAD OF BY A MELTER

on a 60-foot cirle, are placed eight 2-ton hand jib cranes all equipped with ball and roller bearings to increase the ease of operation. Around this same large central jib crane are 34 radial trackways, which with 125 light simply made trucks shown at *A* in Fig. 6 form the machinery for this gigantic molding and casting machine. The layout is shown at the right end of the foundry floor plan, Fig. 1.

The molds are hand-rammed on the floor around the outer jib cranes. They are closed with the aid of these cranes and placed upon the trucks on one of the 34 radial trackways. They are then moved to the center, by being pushed along the trackways until within reach of the central pillar crane which handles the ladles of metal delivered to it from the cupolas by one of the ever-present monorails. The pouring method is illustrated in Fig. 9. As soon as the metal has solidified, the central crane strips the flasks and returns them to a point within reach of the outer jib cranes. The bottom boards with the sand and castings are lowered by the central crane, through the circular opening in the floor, *B*, Fig. 9, where they are deposited upon cars in the basement. About 100 of these cars are provided, so that they may be rolled to one side upon the concrete basement floor and allowed to stand until the casting cools thoroughly in the sand. After shaking-out, the castings are delivered by the monorail crane system to the cleaning room, while the bottomboards are returned to their places at the respective jib-crane stations by means of the monorail cranes, running on a circular trackway just outside of the circumference of the jib crane stations. Sand is delivered to the eight molding units by four chutes served by four elevators leading from the basement floor to points above the respective molding floor stations. By this system as many as 300 castings per day are handled with ease. The balance between molding, pouring and shaking-out is so well maintained that at no time is any unit of this system idle.

FIG. 12—PRACTICALLY EVERY KNOWN LINE OF FEMALE EMPLOYMENT FINDS A REPRESENTATIVE IN THE COREROOM TRAINING DEPARTMENT—VASSAR GRADUATE AND DOMESTIC PROVE EQUALLY APT IN THE ART

The entire molding floor of this foundry is an example of order and efficient arrangement. As has been noted, no effort is spared to have at hand the required flasks, sand, metal and crane service when needed. The molder's preference for a dirt floor is met by clay laid upon a double wood floor covered with tar to prevent dust from falling through into the basement.

Obviously, in the regular progression of materials through the plant, the cores must be delivered to the foundry floor to take their place as needed. The plan view, Fig. 1, illustrates the arrangement by which this is effected. Along the uphill side of the plant, core sand is delivered and stored in the core room at the extreme right, indicated by *A*. Core room *B* is devoted to the lighter cores which may be made and carried by hand. In core room *C*, served by a monorail crane, large cores are produced and its location facilitates the delivery of cores to the molding floors. Above core room *A* is the training room which was constructed at the time women were first employed by the company. Sand is delivered to this upper room and the completed cores are returned to the ground level by a core elevator built by the Link-Belt Co., Chicago. It is interest-

FIG. 13—EACH MOLDER POURS HIS OWN MOLDS IN THE STEEL FOUNDRY, HAND SHANKS BEING USED AS THE WORK CONSISTS SOLELY OF STEEL PINIONS WHICH NEVER WEIGH OVER 50 POUNDS

ing in this connection to observe that although women were first employed in this room only, Fig. 12, they are now working in almost every department of the foundry, including the main molding floor, cleaning room, and welding and cutting department. The final weighing of the finished castings is in charge of a woman clerk.

In core room *A* are located a crushing and mixing machine for reclaiming cores, built by the W. W. Sly Mfg. Co., Cleveland, a 6-foot pan mixer manufactured by the National Engineering Co., Chicago, and two mixers constructed by the Standard Sand & Machine Co., Cleveland. A large number of core machines built by the International Molding Machine Co., Chicago, are used in all the core rooms.

Ample oven capacity is provided. In the small training room located over core room *A* are two drawer type ovens with special electric-motor pressure regulators built by the Avery Co. from plans furnished by the Milwaukee Gas Co., Milwaukee. Core rooms *B* and *C* are served by 11 ovens, seven of which are of the car type. Nine of these ovens are coke-fired and two use gas fuel. The car type ovens are 25 x 6 x 5 feet on the inside, and are charged from both sides. All these ovens were built by the Avery Co. Small cores are delivered to the foundry on special spring trucks, while the monorails carry the large cores.

Female Labor Successful

As was mentioned previously, the initial employment of women was in the core department. The adoption of the piecework system in the core department led to dissatisfaction. The coremakers stated that they could not make $5 per day on the scale adopted and a strike resulted. The company employed a few girls, insituated the training room, and now in all the various core departments, over 40 women are making from $7.50 to $9 per day on piecework scale. The experiment proved so satisfactory that successive steps led the company to try women on other work, such as cleaning up the foundry floor, sorting and chipping castings, oxyacetylene welding and cutting, and finally light molding. Three months have served to demonstrate that women can successfully handle practically any work around the plant.

The use of the basement under the main foundry floor primarily is to afford a convenient place for the conditioning and handling of the sand. As has been noted, the sand from the small and medium castings falls through floor grating into bins in the basement, while that from the large castings is dumped from the bottom-boards in the same room. All this sand is riddled, tempered and delivered to a number of sand cutters driven by 5-horsepower motors. These cutters, each serve a separate bucket elevator, of the type commonly used in grain elevators. The elevators are equipped with special nickel steel chain and wooden buckets to reduce the corrosive effect of the wet sand handled. They carry the sand up to chutes located at various points above the foundry floor. These chutes, two of which are commonly constructed at the upper end of each elevator deliver the sand to the sand tanks for the small molds and to sand piles at the various stations where the medium and large sized molds are made. The sand delivery system is so designed that the sand is delivered at the point desired and allowed to stand a day before it is used.

The recognition of the principle, every man to his job, proved the key to successful electric furnace operation in the Avery foundry. The management conceived the idea that foundrymen, skilled though they might be in melting practice, and in all the lore which goes to make up the expert in handling molten metals, should not be expected to know electrical practice. Accordingly, the electrical department of the main plant was called upon to direct the installation of the single 1½-ton electric furnace.

The electric furnace is used to refine metal for steel pinions which weigh up to 50 pounds each. The normal charge is 750 pounds of punchings from the forge shop; 875 pounds of spring scrap; 875 pounds of light, low phosphorus scrap; 20 pounds of ferromanganese; 25 pounds of ferrosilicon, and 3 pounds of aluminum. High manganese content and carbon from 0.45 to 0.50 per cent is demanded in the metal.

The top and bottom of the furnace is lined with magnesite instead of silica. The original silica brick lining burned through despite the use of 25 pounds of lime for each charge. The carbon consumption averages from 25 to 35 pounds per ton of metal refined, three 7-inch carbons being used. Three-phase current at 60 cycles is delivered at 13,200 volts alternating current, and is transformed to 2-phase at 125 volts for the furnace. The current consumption averages from 500 to 600 kilowatts per ton, and charges have been refined with as low as 480 kilowatts per ton.

The metal is delivered by shank ladles to the steel foundry floor in the same room. An oil-fired, 7-burner ladle heater is used to heat the ladles. It is the intention in the near future to install another furnace of the same size to save the time now lost in charging and melting down. This unit will be placed at the side of the one installed.

Mill Room Reclaims Waste Space

Even the space between two buildings offered suggestions of possibilities to the designers of this foundry. The addition of a tier of steel sash windows, and a trussed roof converted the space between the main foundry and the cleaning-pattern building into an ideal tumbling mill room. Here, on the same level with the basement sand room are located 30 tumbling mills of various sizes, from which the dust-laden air is removed through the suction lines which may be noted in Fig. 8. The largest of these mills is 6 feet in diameter and will handle the larger wheel hubs shown in the illustration. All the mills were built by the Avery Co. in its own shops. Adjoining the mill room is a sand-blast room equipped with apparatus manufactured by the Pangborn Corp., Hagerstown, Md. Only the motor castings are sand-blasted.

On the lower floor of the building adjoining the mill room is the cleaning department. Ten batteries of grinders are located along the wall of this room. Each grinder battery consists of two grinding wheels, belted to a central pulley. Grinding wheels, 24 inches in diameter are placed upon the slow speed machine at one end of this installation, and as they are worn down by use, they are moved along to higher speed machines until entirely worn out. Within this same room the gates and risers are cut from the medium and large castings by a sprue cutting machine. Hand chipping, and where necessary welding or cutting by oxyacetylene completes the progress of castings through the plant. They are then weighed upon the shipping platform and removed to the machine and assembly shops by freight cars. Within a few months, the completed machine shop will add another step in the process of manufacture, and will permit the delivery of the finished machine parts for assembly, only, at the other plant.

Patterns and Storage

The second floor of the building in which the castings are cleaned is occupied by a modern, well-equipped pattern shop, with machinery for making the wood patterns from which metal patterns are cast, and also metal working tools for finishing the aluminum match-plates and other metal patterns. Adjacent to this shop and on the same floor is storage space for the large number of patterns which enable the company to make replacement on machines constructed years previously.

Across the tracks from this pattern and cleaning building is the newly constructed machine shop. Machine tools are located on the first and third floors and the intermediate floor will be devoted to a complete tool room, motor assembly and the cafeteria. The latter has been in operation for several months and is one of the points of progress which characterizes the operation of the plant. This restaurant serves over 500 meals at cost to the workmen during the noon hour each day. The company pays all overhead charges, such as light, fuel and service. The lunch hour is arranged in shifts so that at no time is the restaurant crowded beyond capacity. The basement of this building will be devoted to parts storage.

The Avery Co. employs 500 men and women in all departments of its foundry. Of this number about 125 are engaged in molding and only about 40 are skilled molders. It has been the policy of the company to take untrained men or women and train them within its own plant, and this policy has aided in overcoming the labor shortage which threatened production in many plants during the summer and fall.

Credit for the success of the foundry is due to the engineering skill of W. J. Brandon, mechanical engineer and works manager for the entire plant, and to L. A. Phelps, foundry superintendent. The electrical appurtenances, and the electric furnace installation have been supervised by Fred Sims, plant electrician.

The Charles C. Kawin Co., Chicago, is supervising the erection and equipment of a foundry which is being built for Montgomery, Ward & Co., Chicago, at Springfield, Ill.

Changing Patterns to the Best Way of Molding

Patterns Which Yield the Best Castings in the Easiest Way Are Characterized and Methods of Producing Them Are Analyzed

By R R Clarke

NOT a few jobs coming into a foundry include some molding feature distinctively laborious and time killing, some simple details of the process opposing a more rapid, easy and efficient production. In such cases the true foundryman will set his wits to the possibility of facilitating matters since by a few simple obstructions removed the road will be cleared. The proposition of course embodies study, frequently including also some change in pattern or equipment which is often well worth taking. The time, labor and expense saved by such change is often eminently well spent.

The significance of a good pattern is too far on in the advanced course of foundry mathematics to fully calculate. What is a good pattern? The question must dictate its answer from a dual consideration, designating it that which yields the best casting in the easiest way, not the best easiest way, mark you, but the other way around. If I make and pour heavy pin brass in a lying-down position, I make it the easy way. If I make it standing up with a gate at the bottom I make it the best way. If I go to the trouble of making a three-part flask, with the middle part exactly equal in depth to the length of the pattern for the pin, then I can make heavy pin brass in the easiest best way. Or again, if I make locomotive crown brasses standing on end I make them a comparatively hard way and not so good. If I make them with a dry-sand journal core, journal up, I make them an easy though somewhat expensive way. If I make them with a green-sand core, journal down, I make them the best way. But if I equip with flasks and follow boards so that the flask parting will be the exact contour of the pattern, yielding for a cope-pattern impression nothing but a semi-circular plane, then I make locomotive crown brasses in the easiest best sand-molding way. Still another example. If I want to cast medium-sized bushings on end, bushings say 2½ inches outside, 1½ inches inside by 12 inches long, I can make end-draw pattern with core prints on both ends and ram up vertically. That's one way. Or I can use split patterns and the open-end flask ramming up horizontally, clamping ordinary bottom boards over cope and drag surfaces, up-ending the flask, and thus pouring. That's another, easier way. But if instead of ordinary bottom boards and clamps I equip with strong, uniformly level iron plates and similarly dependable screw clamps, then I make a move toward the easiest best way.

We might consider a single additional case. We want to mold valve discs with a guiding stem attached, as shown in Fig. 1. We can make split patterns and mold them in a lying-down position. That's easy but it throws the seat of the disc, a critical casting part, in bad mold position. Well, we'll make them in a standing-up position with the seat in the drag of the mold. That's logical. Now we can do that in one of three ways. We can make a solid pattern and follow board, the pattern to include a core print on the cope side. This print should have ample draft to facilitate lifting the cope and to account for a dry sand core for the top stem on the casting. This is a hard, expensive way.

We can make a solid pattern and a follow board pattern to account for the upper stem in the green sand of the mold. That means a hard cope lift and more than one bad mold, loss of time naturally attending. But we can make the top a detachable piece which in hand molding is good judgment. We can make it as shown in Fig. 2 or Fig. 3. What's the difference? In Fig. 2 we have as possibilities, first, a dowel pin sticking and a resultant breakdown in the mold; second, a top stem rammed out of perpendicular; and third, eventually by pin and hole wear an out of center position. In Fig. 3 we recede perceptibly from any one of these evils and the difference in the casting is all in the pattern.

It's a great study this. In foundries so fortunate as to make or superintend making their own patterns, this happy condition of the easiest best way is not difficult to realize, being a mere matter of talent and studious application. In those forced to accept patterns from any source, the situation is widely different. So much so, indeed, that this is one of the prime distinctions we have found between running the individual and the jobbing shop plant. In the one it is simply a case of get what you want, in the other take what you get and make the best of it. The question then reduces itself to the time and expense of either making a new pattern or changing the old with the customer's consent and if possible his liability as well. In either case our experience has been that when clearly justified that is an excellent thing to do. It is all that, by virtue not only of advantage in expense and output but also in demonstrating spirit and ability to turn from old ruts into new tracks.

We have often wondered how, when and where some patterns ever derived their origin of design. We have marvelled further how many could so long survive average foundry intelligence instead of perish in it as should have been the order. A very limited experience in jobbing work will readily convince the lay foundry mind that the world's knowledge of founding includes quartered ideas yet very crude, ideas proceeding from the finished pattern-maker all down the line through the hatchet and saw man to the pen-knife, cigar-box lid devotee. Some are sorry sights to be sure. Yet it is not always the rougher looking pattern that offends most. The

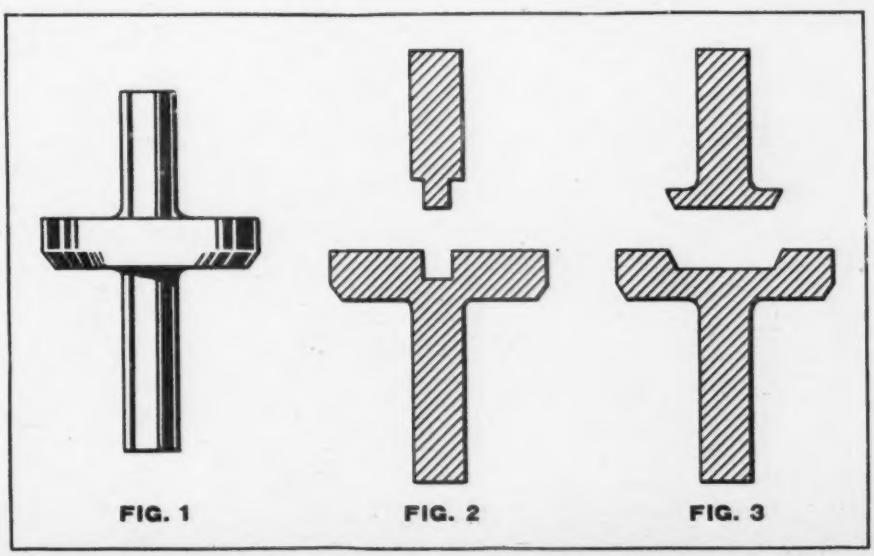


FIG. 1—VALVE DISC CASTING FIG. 2—ONE WAY OF MAKING THE PATTERN
FIG. 3—ANOTHER AND BETTER WAY

better finished may be equally if not more transgressive of good foundry taste. The one violates act, the other, principle or economy. Between the two, the former is the less serious yet to both a well-considered change is due.

We might profitably illustrate. Within the past month two medium-sized bushing patterns have been received at our foundry, the one calling for 24 castings, the other for 190. The first pattern was a solid rough hewn affair yet workable and with true to size core points. The second was well finished, but at the union of core prints with the body a large, long, tapering fillet occurred at either end, adding that much to the co-existing evil of undersize prints. The metal that had to be chipped or ground off amounted to at least a full pound per casting and the clear need of alteration was clearly established. The change was made at our own expense to straight core prints of proper size and a distinct saving was realized. Another example along the bushing line was a pattern just ½-inch too long for our standard 12 x 16-inch flask. The core prints were more than amply long. Eighty castings were wanted so we shaved the ends of the prints to fit the flask, stopped off the core box and escaped the larger-sized flask.

The great argument in vindication of changing a pattern to an altered molding method is output and quality. In either case output is nearly always ultimately the factor. Taken day in and day out it is almost universal experience that a molding method that at best will produce a low quality casting will at the foundry inevitably produce an amazing sum total of worthless castings so that if even the better method be less speedy it will nevertheless in the long run be found the more productive. Mere molds are no criterion of logical pattern and method. What crosses the scales to the consumer on to good service is the better indicator. But when speed and quality go hand in hand with the monetary consideration—and they often do—then the call for change becomes the more distinct. Why different foundries will continue to run in the same old groove in making duplicate work when the advantages of a pattern change are so apparent and real is one of the seven wonders of the foundry world.

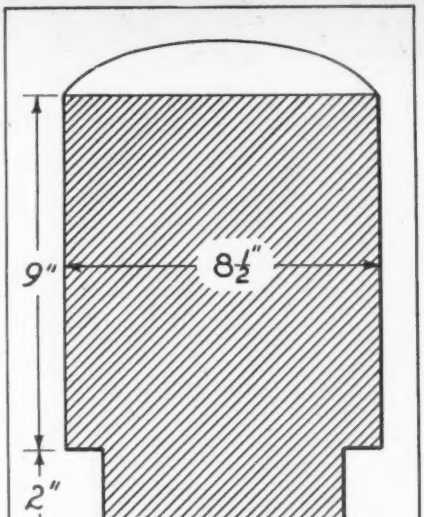


FIG. 4—BUSHING PATTERN AS DELIVERED TO THE FOUNDRY—TWO HUNDRED CASTINGS WANTED

To clearly and finally illustrate this advantage we cite the following from actual and very recent experience. Two hundred bushings, as shown in Fig. 4, were ordered along with a 20-ton lot of castings for winches on ships under construction. The pattern had been used long and often before and came to us exactly as shown, being made upright with a dry-sand core and no cope print. Here we had a bushing 8½ inches outside diameter, 7 inches inside diameter and 9 inches long for which 200 dry-sand cores would have to be made, which would greatly retard the molding operation. The folly of the dry core was so apparent that we at once made an aluminum pattern to account for its own green-sand core. We wanted to work the pattern on a straight hand-jolt machine, gating at the bottom and escaping if possible the rolling-over of the drag since that would represent a cumbersome, two-man, time-killing operation, which when executed 200 times over would amount to something.

We had interchangeable flasks, 4-inch cope and 4-inch drag, and decided to use them, using two parts on the drag and one on the cope. This gave us a drag 8 inches deep. We then had a solid round disc turned up measuring 8½ inches in diameter and 1 inch thick. This we tacked to a follow board and had a 2-inch upset or frame of the same dimensions as the interchangeable flask in length and width squeezed up on a hand squeezer. These frame molds were then taken to the hand jolter and the bushing pattern set in the disc impression. A bottom-gate core was then set in position, the drag set on the frame, with a gate pin in position and the jolting started. That gave a level top parting. A logical relative sand density as realized by the jolting together with the advantage of making the copes independent of the drags. It also evaded rolling-over the drag. Following jolting, a level parting was made and the pattern drawn by hand. Copes were then squeezed up and the molds assembled for pouring. It's not a case of figuring but of actual practical fact that we increased production over 50 per cent and reduced cost by a still greater figure to say nothing of the hard labor we eliminated from the process. Incidentally the same plan could have just as easily been followed out in straight hand molding. This plan to our mind includes all features of the easiest best way of adapting the pattern.

How Gun Metal is Affected by Impurities

By F Johnson

THE literature on the influence of impurities on the mechanical properties of admiralty gun metal contains little concerning results of tests. So far as the author has been able to ascertain no attempt appears to have been made to make up alloys of admiralty gun metal composition from pure metals under standardized conditions and to determine the alteration in mechanical properties which may be brought about by the addition of other metals. This is what the author, under adverse conditions as regards time, material and assistance, has attempted to do.

The choice of admiralty gun metal as the basis alloy may appear to some as requiring justification. The justification which the author offers is that this particular alloy finds greater favor among engineers than any other alloy composed mainly of copper and tin, if the extensive and highly important series of phosphor bronzes be excepted. The popularity of this alloy is based on no misconception. It is undoubtedly superior to its progenitor, zinc-free gun metal.

As a casting alloy it possesses few equals among the alloys rich in copper, while its range of mechanical properties may be enormously extended by heat treatment. Unannealed castings are used for journal bearings, water and steam fittings, etc., while annealed castings are probably better for fittings of pumps used for pumping mine water and other corrosive liquids.

Unannealed castings have a metastable structure, the tin-rich eutectoid being present only on account of the relatively rapid rate of cooling. Thus one of the necessary conditions of a bearing metal is fulfilled, a uniformly distributed phase (delta) of great hardness possessing a low coefficient of friction in a relatively soft matrix (alpha phase) possessing good thermal conductivity.

Annealing, if sufficiently thorough, establishes equilibrium, the eutectoid reverting to the homogeneous beta phase, this in turn passing into solution in the alpha phase.

Thus an alloy consisting entirely of homogeneous alpha may be produced by annealing, and this should be more resistant to corrosion than the metastable alpha + eutectoid structure in the unannealed casting. There appears to be no experimental evidence on this point, but it seems

From a paper presented at a meeting of the Institute of Metals, London, recently. The author is a metallurgist of Birmingham, Eng.

reasonable to assume that the obliteration of an electronegative constituent by annealing should serve to reduce corrodibility.

One authority states that aluminum is never found in gun metal unless purposely added. He says the drawbacks to its use consist of the formation of a skin, alumina, on the skimmed surface of the molten metal, the increase in contraction and an increase in corrodibility. The author would point out, however, that the increase in contraction must be regarded, if unaccompanied by disadvantageous structural changes, as proof of strength and soundness. One has not to seek far for an analogous case. The addition of phosphorus to tough-pitch copper results in the formation of a depression at the surface of an ingot which would otherwise be level. Visual examination of the fracture or microscopic examination of a polished surface proves that the addition of phosphorus has eliminated gas cavities while chemical examination would show that the gases which caused those cavities had also been eliminated. Thus the condition which is opposing the natural property of the metal to become more dense, and therefore to occupy a smaller space when solid than when molten, is removed.

Physical and mechanical tests show that phosphorized copper is denser, stronger, and tougher than tough-pitch copper. Similar beneficial results accrue from the addition of small quantities of aluminum to admiralty gun metal. The author would plead for a reconsideration of the use of aluminum, believing that foundrymen could produce improved castings by efficient feeding, using adequate runners and risers. There is, however, the other, and possibly more serious, objection to its use, the formation of a tenacious film of alumina. This trouble is increased rather than mitigated by remelting. Possibly some efficient flux such as cryolite may be pressed into the service of foundrymen to obviate this drawback. The author has greater faith in the employment of some such specific as aluminum or phosphorus for the elimination of unsoundness than in merely controlling temperature, while not losing sight of the fact that control of temperature, either by pyrometer or by expert judgment, cannot fail to contribute toward the same end.

Arsenic is Beneficial

The author is not disposed to quarrel with the introduction of arsenic into admiralty gun metal as proposed by some authorities. More important than a slight lowering of tensile strength and elongation is an increase in soundness. It has been proved that arsenic can act beneficially on copper in reducing porosity. That it can act similarly in admiralty gun metal is by no means a rash assumption.

Bismuth is rarely present in reputable brands of copper in amounts likely to be harmful. The presence of lead lowers the rate of wear when gun metal is used for bearings but increases the friction coefficient. None of the recent investigators has a good word for the presence of iron in the metal and little seems to be understood about the influence of nickel. One authority does not favor the addition of nickel owing to its alleged action of liberating occluded gas during cooling of the casting, thus causing porosity. A beneficial influence in aiding to form a dense close-grained structure and in lowering the rate of wear has been claimed for its use.

The practice of using silicon as a deoxidizing agent in preference to phosphorus for bronze for electrical purposes is old. Investigation would indicate that a small amount of silicon as a deoxidizer does not improve the mechanical properties of zinc bronze to any extent.

The main features of interest may be summarized as follows:

Lead does not appear seriously to affect the mechanical properties, although it is possible the resistance to shock is lessened by the addition of this metal.

Iron has a beneficial influence on mechanical properties, yield point, tensile stress, and elongation all being raised. Its effect on pouring qualities is bad, but much improvement is effected in this respect by the addition of a trace of aluminum to influence fluidity.

The influence of manganese is bad in every way, the mechanical properties being adversely affected and the pouring qualities also. The surfaces of the castings were bad.

The annealing treatment goes far toward eliminating ill effects produced by undesirable additions, notably aluminum and silicon. The general improvement brought about by annealing is extremely remarkable.

Gas-Fired Furnaces for Brass Melting

IN AN address presented before the Manchester and District Junior Gas Association, entitled "Gas-Fired Melting Furnaces," by Arthur Forshaw, reference was made to the progress in crucible furnace construction in the past few years. It was pointed out that while gas-fired furnaces have been on the market for nearly a decade, the bulk of the nonferrous metal in Great Britain is still being melted in coke-fired furnaces.

According to Mr. Forshaw the efficiency of the best pit-type, coke-fired furnace is as low as 5 per cent. This, he contended was a great improvement over some of the earlier types of coke-fired furnaces whose efficiency was not in excess of one per cent. The usual manner in which coke furnaces are rated is by weight of fuel consumed, expressed as a percentage of the weight of metal melted. In the most efficient pit-type furnace used at present this figure is about 30 per cent, or from 670 to 780 pounds of coke per ton of brass melted, while in the original, square type coke furnace it was about 150 per cent. This low efficiency was due almost entirely to improper lining. When the lining must be renewed in the most modern pit-type coke furnace the old one is chipped out and the new one, in one piece, is placed in position. By this method the furnace always starts with a new lining of correct size. Several furnaces are connected to one flue, the draft for each being controlled by the opening in the lining fuel consumption is reduced by the use of special bars which permit the easy withdrawal of clinkers. Nearly all the most efficient pit-furnaces are square, providing fuel reservoirs at the corners. These provide space for raking large lumps of coke into the corners without liability of damaging the pot. The square furnace also insures the easy introduction of tongs, but the round furnace has a slightly greater efficiency, provided the coke is graded to the proper size.

Comparison of Furnaces

Coke-fired tilting furnaces are close competitors of gas-fired furnaces, as they are claimed to have an efficiency of 15 per cent. The author ventured the opinion that too much attention is given to the consumption of fuel and too little to other factors that enter into the melting of metals.

In comparing gas-fired with coke-fired furnaces, Mr. Forshaw said that the cost of lining coke furnaces is less than that of gas-fired furnaces. While the lining of the coke furnace is subject to erosion by the coke, the space between the furnace walls and the crucible is not so restricted as in the gas furnace. Slight wear of the coke furnace lining is reflected by a limited increase in coke consumption, whereas in a gas furnace the space between the lining and the crucible must be maintained within narrow limits, and the furnace must be lined more frequently than the coke furnace. One difficulty that is experienced in gas-fired furnace operation is due to the slag running down the furnace walls and dropping on the burner. To overcome this, the burners of some furnaces have been located on top, but this has not proven very successful. The damage to linings of gas furnaces is caused by metal splashed onto them by careless workmen in stirring the metal. The action of such split metal is destructive to the linings. The temperature, while higher than in coke furnaces is not sufficient to damage the linings. This has been proven by running a large tilting furnace with an empty crucible, continuously for a week at a temperature much higher than that required in actual practice. After this test the lining was practically the same as when the test was commenced and the only sign of fusion was at one spot where a small piece of iron had lodged on the brickwork and had melted and run down the furnace wall, cutting a channel in the surface of the lining, from top to bottom where it had fallen in the form of slag.

To preserve the linings of gas-fired

furnaces the slag must be removed at frequent intervals. After resorting to many expedients to accomplish this, a device was built for dropping the bottom which is controlled by a hand wheel above the floor level. This permits the slag to be knocked off while hot.

Mr. Forshaw said that 500 heats for a small pit furnace melting gun metal or brass is not unreasonable, and exercising care in melting this might be increased to 800 heats. Melting aluminum, a much higher record may be attained. The more rapidly the furnace is operated, the greater the wear and tear on the lining. On the other hand, continuity of melting insures economy, as every time the furnace is cooled and reheated, the contraction and expansion is injurious to the lining. Speeding-up production pays, but the furnace must be designed for the material to be handled. For example, a cupro-nickel furnace is equipped with greatly increased burner power and is more perfectly heat insulated than a furnace designed for brass only. On the other hand, a furnace designed for brass would not attain the temperature necessary for cupro-nickel, but if it did, the gas consumption would be higher than necessary to melt the material economically.

PROBLEMS OF THE BRASS FOUNDER

What To Do and How To Do It

Preparing Facing for Bronze Tablets

Will you please inform us how to mix facing sand for molding bronze tablets, name plates and ornamental work of a similar character? We would like the formulas for both skin-dried and dry-sand work.

A sand that is strong without much bond and fine without being impervious to the gases generated by the hot metal running over it, is what is required for making such castings as tablets. These conditions are met by prepared sands that can be purchased in barrel or larger lots from any dealer in foundry supplies. This sand usually is red in color, is dry and of great fineness. It is tempered with water and after the molds are made they are sprayed with molasses water. Cheap molasses should not be employed if it contains sulphur dioxide. Some tablet makers use French sand exclusively and make the facing by grinding together new and old burnt sands.

A facing sand also can be made by screening new molding sand through a No. 18 sieve, adding one part flour to 15 parts of dry sand and tempering with molasses water. If the patterns can be printed-back, a very fine casting can be obtained. To print-back, burn some new sand until it is red and when cold, screen it and place it in a fine linen bag. After the mold has been finished and sprayed with molasses water, this fine sand is dusted over the impression, being careful not to fill up the letters. On top of the sand a good parting compound or lycopodium is dusted. The pattern then is returned, the cope closed, the mold rolled over and some of the sand is removed; the mold then is butt-rammed carefully, after which it is again rolled over, the cope removed and the mold finished. This will leave a fine impression which should be torched until it is thoroughly skin-dried. The mold should be closed while warm and should be immediately poured.

For dry-sand molds it is necessary to mix a binder with the sand, the same as in making cores and about the same amount should be used. The best binders for this work are those with a starch base. The molds should be well vented with needle vents to enable the gas from the burning binder to escape freely. Use new molding sand almost exclusively for the facing and screen it through a fine sieve to get a surface next to the patterns that is smooth and not porous, otherwise the castings will be rough.

Preventing Dross Imperfections in Bushings

We are making bushings, approximately 4¾ inches in diameter, 5 inches long and ⅝-inch thick. We experience trouble from dross and holes just under the skin next to the core, which are invisible until the casting is bored out. The cavities appear to cluster midway the length of the bearing and seem to come from the core. The alloy is a leaded bearing bronze and we are sending you a sample casting broken to show the difficulty of which we complain.

The trouble is due to a reaction between oxygen and sulphur. The metal has been oxidized rather freely. This is indicated by the black spots on the outer surface of the casting, which are produced by the oxidization of the lead and tin. When this oxidized metal comes into contact with sulphur it is reduced to metal with the formation of sulphur dioxide, a gas soluble to some extent in the alloy. This gas forms the holes in the casting. These holes are lined with a film of metallic sulphides, which on being touched with hydrochloric acid evolve hydrogen sulphide, easily recognized by its odor. The question is where does the sulphur come from? If plaster of paris is being used as a flux, as is common practice with leaded alloys, the sulphur is derived from an excess of the flux. The remedy is to use less and avoid the oxidation of the metal when it is being melted. If no flux is being used the sulphur may be obtained from the fuel or from some binder used in the core or on the wash put on the core. As the metal is dense and solid except where it touches the core it looks as if the latter were at fault, and the first change should be made in the core. Change the binder to something of the nature of dextrin, and instead of washing the core, coat it with powdered whiting. If the metal is melted without a cover, use hardwood blocks and a little salt when melting down.

Government Specifications for Various Bronzes

We would like to obtain the government specifications, either navy or army, for the following alloys: (1) *Hard gun metal;* (2) *phosphor bronze;* (3) *ordinary bronze castings;* (4) *brass castings. In the particular case where we intend to use these castings they will be subjected to great pressure as they are to be used for bearing bushings in connection with dredge work.*

The specifications should give the composition of the foregoing alloys as well as the modulus of elasticity, and, if possible, the degree of hardness.

Navy department specifications for gun metal, cast or composition *G*, follow: Copper, 87 to 89 per cent; tin, 9 to 11 per cent; zinc, 1 to 3 per cent and lead, maximum, 0.20 per cent. The physical properties follow: Minimum tensile strength, 30,000 pounds per square inch; minimum yield point, 15,000 pounds per square inch; minimum elongation in 2 inches, 15 per cent.

For phosphor bronze, cast, composition *P-c*, the specifications are as follows: No. 1—Copper, 85 to 90 per cent; tin, 6 to 11 per cent; zinc, not over 4 per cent; iron, maximum 0.06 per cent; lead, maximum, 0.2 per cent, and phosphorus, 0.5 per cent. No. 2—Copper, 85 to 90 per cent; tin, 6 to 11 per cent; zinc, remainder; iron, maximum, 0.1 per cent; lead, maximum, 1 per cent, and phosphorus, 0.5 per cent.

The physical properties for No. 1 provide for a tensile strength of 45,000 pounds per square inch as the minimum and an elongation of 20 per cent in 2 inches. No. 2 alloy: Tensile strength, 30,000 pounds per square inch and an elongation of 15 per cent.

For bronze journals, composition *H*, the specifications are as follows: Copper, 82 to 84 per cent; tin, 12.5 to 14.5 per cent; zinc, 2.5 to 4.5 per cent; iron, maximum, 0.06 per cent and lead, maximum, 1 per cent. The normal composition of this alloy follows: Copper, 83 per cent; tin, 13.5 per cent and zinc, 3.5 per cent. This alloy is a hard bronze. Composition *G* is for ordinary bronze.

The specifications for brass castings follow: Copper, 60 to 63 per cent; tin, 0.05 to 1.5 per cent; zinc, remainder; lead, maximum, .03 per cent. Normal

composition: Copper, 62 per cent; tin, 1 per cent and zinc, 37 per cent.

The specifications of the bureau of steam engineering for commercial brass are as follows: Copper, 64 to 68 per cent; zinc, 32 to 34 per cent; iron, 2 per cent maximum and lead, 3 per cent maximum.

The modulus of elasticity and the Brinell hardness are not furnished with the specifications.

Clay Mixtures for Lining Ladles

We would like to obtain a clay mixture for lining ladles used for pouring iron. The mixture we have been using flakes off instead of adhering to the ladle.

Probably too much clay has been used in the daubing. This produces a lining that cracks as it dries which would naturally result in flaking. It is necessary to incorporate a considerable amount of sand with the clay to offset the shrinkage. A rich and sticky natural loam makes an excellent daubing material without the addition of any clay. Possibly the sand dealers could supply such a loam. The following mixtures are in service: (1) Fireclay, 2 parts, and new molding sand, 1 part. Mix thoroughly and wet with plain water. Dry slowly at first. (2) Silica or core sand, 1 part, and new molding sand, 1 part. Mix thoroughly and wet to proper consistency with thick clay wash. The less fireclay used the more economical the daubing; therefore, efforts should be directed toward dispensing with fireclay. This can be accomplished satisfactorily by using loamy sands.

Ash Metal and Its Use

Will you kindly inform us what the copper alloy known as ash metal is? For marine brass the formula calls for ash metal, 90 per cent; yellow metal, 10 per cent, and for valves, ash metal, 50 per cent; copper, 40 per cent; tin, 8 per cent, and zinc, 2 per cent.

Ash metal is the term applied in England to brass recovered from the furnace ashes. It is a mixture of all the different kinds of brass made in the foundry where it originates. Consequently, nothing is certain about its composition, as this will vary with every foundry. In foundries specializing in yellow brass the ash metal will be low in zinc as much of the latter metal will be burnt out in passing through the fire. In this country recovered metal is not known as ash metal, although this is an indicative term. Any recovered metal can be used as ash metal in the mixtures mentioned, and lacking recovered metal, scrap brass can be substituted. The most satisfactory manner of using recovered metals is to have them run into ingots by a smelter employing a reverberatory furnace to run off large heats; the ingots are analyzed and the recovered metal is used in the regular brass mixtures, by adding copper, tin, zinc or lead, as required. If the ash metal is oxidized, a small amount of phosphor-copper should be included in the mixtures; about 0.25 per cent is sufficient for the purpose. Ash metal also can be used as recovered or in the manner given in the mixtures in which case it is confined to the cheaper class of copper alloy castings.

Pits in Bronze Molds

We are making bronze molds for the production of castings of Britania metal, and we find that the bronze when finished shows pits just beneath the skin which, of course, makes the molds unfit for use. We are at a loss to account for this difficulty and would appreciate any suggestions you may be able to offer. We use the following mixture for making the bronze mold castings: Copper, 90 pounds; tin, 4.75 pounds; lead, 0.75 pound. The molds which are faced with Windsor Locks sand, are skin-dried and smoked with rosin to produce a fine surface on the castings.

There are several possible causes of this trouble, but the most likely one is that the holes are due to gas produced in the metal itself as it is melting. Such gas is produced by the simultaneous presence of sulphur and oxygen in the metal. Sulphur is absorbed from the fuel and oxygen from the atmosphere, but if the metal is protected from either, the other will not cause porosity. To accomplish this, cover the metal when melting with charcoal which prevents direct contact between the air and the molten metal, and greatly lessens the chances of oxidation. A little calcium chloride, or sodium sulphate placed in the bottom of the crucible will reduce the chances of sulphur contamination. The latter can be obtained from dealers in photographic chemicals, but the former is the cheapest. The alloy you are using is easily oxidized if made as stated. It should be changed to the following: Copper, 90 per cent; tin, 4.75 per cent; lead, 1.75 per cent, and zinc, 3.5 per cent. Also, as a matter of precaution, it would be advisable to vent the nowel of the mold with a fine knitting needle to enable the generated gases to escape easily.

Preventing Porosity in Aluminum Balls

We are casting 3-inch aluminum balls, but we experience difficulty in getting good castings. The balls, when machined, are porous and dirty near the point where the gate has been located. We have tried the following alloys: (1) Aluminum, 90 per cent; copper, 6 per cent and zinc, 4 per cent. (2) Aluminum, 92 per cent and zinc, 8 per cent.

The dirt may be due to the presence of sand, washed from the core or the mold. If this is found to be the case after investigation, the core should be surface-hardened by spraying with molasses water before baking. The mold should be carefully cleaned and the gate well *thumbed* to press down any grains of sand that might be washed into the mold. Porosity is usually due to overheating the aluminum in the furnace and by pouring the metal into the molds at too high a temperature. Pour just as cool as it is possible to get the castings to run; if the metal looks silvery so much the better, provided the castings are filled. A short time before the metal is removed from the furnace, add a small piece of fused zinc chloride; a piece the size of a hickory nut is large enough for a pot of aluminum. If zinc chloride is not readily obtainable, use salammoniac. However, zinc chloride is to be preferred, as its use will clean the aluminum of suspended oxides bringing them to the surface where they can be removed with a skimmer. The metal is thus left clean and bright, and if poured at a low temperature good results will ensue.

How to Prevent Porous Bushings

We are making bushings, 9 inches in diameter, 12 inches long, and ⅝-inch thick and some of these are porous. The mixture is ounce metal, half of the charge being new material and the remainder turnings and borings. The brass is being melted in an open-flame furnace.

Porosity usually is caused by the oxidation of the metal. However, if sulphur is not present this oxidation does not necessarily result in porosity, since castings, filled with oxides frequently machine satisfactorily and apparently are sound. Sulphur and oxygen unite to form sulphur dioxide gas which aerates the metal in the same manner as carbonic acid generated by the action of yeast makes porous bread. The use of salt as a flux will materially aid in remedying this condition. In melting, it is advisable to melt the new metal first and to dissolve the turnings and borings therein. The latter expose such a large surface to oxidation that porous castings are liable to result. The openings in the furnace should be as small as possible to retain the pressure and to keep out the air.

Mixture for a Low Shrinkage Pattern Metal

We would like a formula for a metal to be used for making small patterns, something not too expensive and having very little shrinkage. We have tried type metal, but desire a stronger mixture.

Alloys of the type metal class make the cheapest pattern metals as they consist largely of lead and antimony. The following alloy is frequently used for white metal patterns: Lead, 80 per cent; tin, 10 per cent and antimony, 10 per cent.

The most satisfactory alloy from a nonshrinkage point of view is composed of 50 per cent tin and 50 per cent zinc. This alloy should be made by first making a deoxidizing alloy consisting of 90 per cent zinc and 10 per cent aluminum. This alloy is produced by first melting half of the zinc and getting it hot enough to flare a little when the aluminum is added in the form of small, thin pieces and, if necessary, additions of cold zinc are made to keep down the temperature of the zinc so that it will not flare too strongly. The balance of the zinc is added after the aluminum reduces the temperature of the whole so there is not excessive loss from volatilization while the alloy is being ingoted. The pattern alloy is made by melting 49 per cent of zinc, adding 1 per cent of the aluminum-zinc, then following with the tin. The final alloy will be bright and fluid and will run extremely well. The small addition of aluminum will not materially affect the shrinkage properties of this pattern alloy.

Continuous Two-Story Foundry Proves Economical

Extensive Handling Operations Encountered in the Modern Foundry Are Most Readily Performed in a Building of Multi-Story Design

By J F Ervin

TO convey a vivid understanding of the methods followed in a foundry devoted to the production of castings such as are used in the modern gas engine, it is necessary to give a general outline of the material handling operations which make the foundry an economical producer. Four basic materials, namely, iron, molding sand, core sand and refuse, must be handled in the best possible manner.

Fundamentally the ratio of good castings to the total melt on this class of work ranges close to 60 per cent. The ratio of the molding sand which must be handled to the metal poured, is five to one. Of this molding sand, approximately 240 pounds must be added to the heap in the form of new material for each ton of iron melted. The ratio between the core sand and the tonnage of good castings is approximately four to five. Refuse material consisting of largely refuse core and molding sand, has a ratio of one to one of good castings which are produced.

Abstract of a paper presented at the Milwaukee convention of the American Foundrymen's Association. The author, J. F. Ervin, is manager of the Michigan Motor Castings Operating Co., which is a division of the Buick Motor Co., Flint, Mich.

Consider first the iron. In order to put the iron through the cycle of operations it is first necessary to unload it from the car. It must then be successively (2) transported to the charging platform, (3) charged to the furnace, (4) transported to the molding floor, (5) transported from the ladle to the floor, and poured. (6) The iron is now in the form of a casting, and must be removed from the mold to a truck. (7) From the truck it is taken to the knockout platform; (8) from the knockout platform to the sandblast; (9) from the sandblast to the tumbling mill; (10) from the tumbling mill to the emery wheel; (11) from the emery wheel to the chipping bench; (12) from the chipping bench to inspection; and (13) from the inspection to the car. This makes a total of 13 basic operations in handling the iron.

From these data we see that it is necessary to melt 3400 poupnds of iron to produce one ton of good castings, and it is therefore necessary to handle 3400 pounds of iron in the form of raw pig, molten iron, molded castings, gates and sprues, etc., 13 times. This is the equivalent of 22 tons of material to be handled for each ton of castings produced.

Now consider the molding sand. New sand must be handled from the car to stores and from stores to heap, 240 pounds of sand being necessary for each ton of iron melted. This is, therefore, equivalent to 400 pounds for each ton of castings produced. Two handlings make a total of 800 pounds of material to be handled per ton of castings.

Since the sand is now in the heap, the next operation is the handling from the heap to the mold. Handling the mold from the bench or machine to the floor, knocking out the sand into the heap, and cutting over the heap follow in the order named. Since 3400 pounds of iron must be handled per ton of good castings produced, it is necessary to use five times as much sand as iron melted, or a total of 17,000 pounds for each ton of castings must be handled through each operation. The four operations give a total of 68,000 pounds. Add the necessary handling of new sand which must be introduced into the heap and the total is 70,000 pounds, or 35 tons.

Core sand must be handled from the car to the yard as the first operation. Next it must be taken (2) from the yard to the inside storage; (3) from the inside storage to the mixer; (4) from the mixer to the

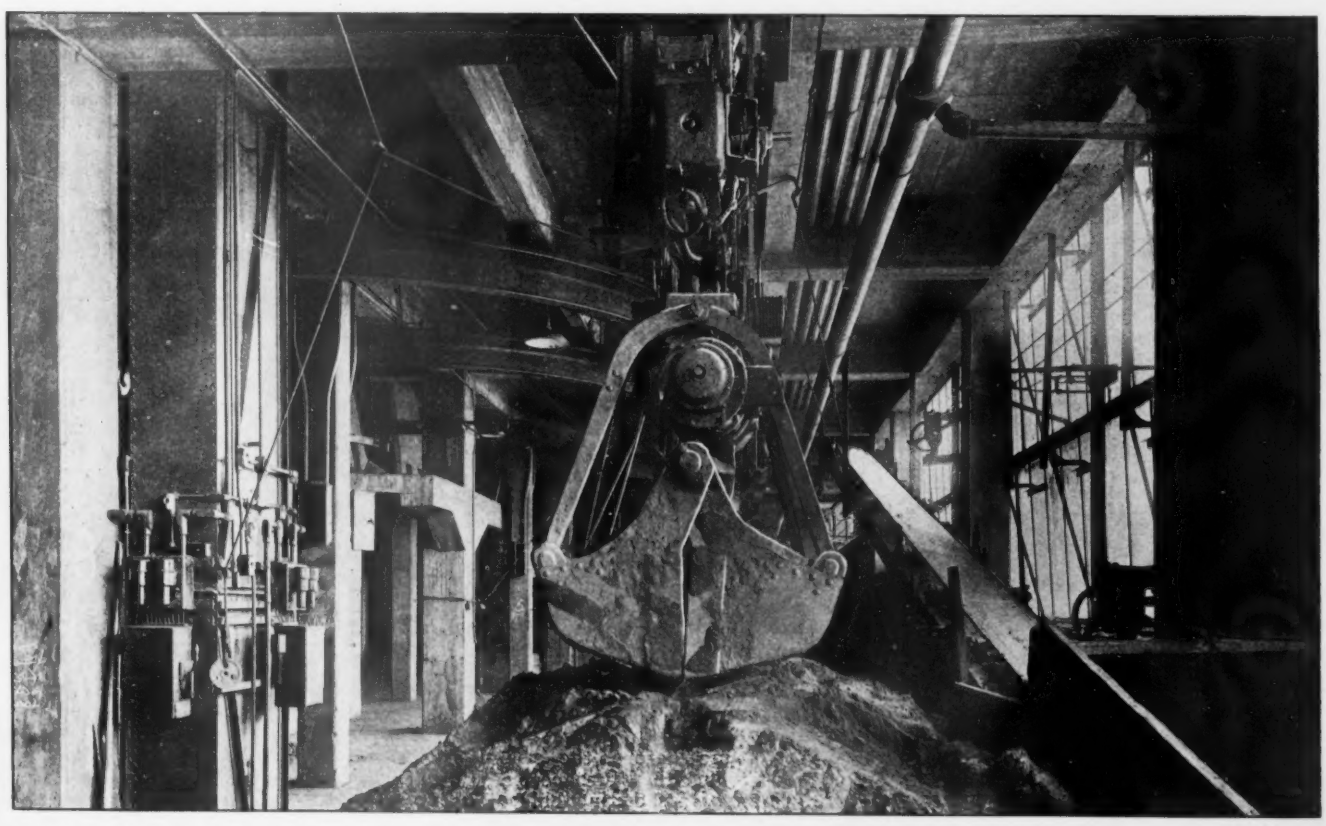


FIG. 1—GRAB BUCKET ON MONORAIL OVER SAND HOPPERS FOR REMOVING SAND FROM THE BASEMENT HEAPS TO THE ELEVATOR WHICH TAKES IT TO THE SAND HOPPERS IN THE ROOF

core bench; (5) handled on the bench during the process of core making; (6) handled to the core oven; (7) from the core oven to the finishing bench; (8) handled in the finishing operations; (9) handled in the inspection operation; (10) transported to the foundry; and (11) placed in the mold.

This shows a total of 11 operations based on a ratio of 1600 pounds of material for each ton of castings produced, giving a result of 17,600 pounds of material to be handled or approximately nine tons.

The next item of considerable importance in connection with the handling of materials is refuse. All bottom boards and other manufacturing equipment.

To do this work efficiently, numerous mechanical developments, both along the line of machine and building equipment have been introduced and operated with more or less satisfaction. The existing labor shortage has prompted many manufacturers to resort to expensive mechanical installations in order to obtain more production from each man on the pay roll. The increased cost of labor has had a great influence on the development of such equipment.

In designing a foundry one of the items which must be taken into consideration is the cost of land. High land values have made it quite profitable for manufacturers of various products to resort to multiple story buildings. In most cases up to the present time foundries have been operated in one-story buildings. The high cost of land, coupled with many suggestions by engineers and others looking toward a solution for some of the difficulties of material handling, has in the course of the last few years developed the two-story foundry.

The purpose of the multi-story foundry is to obtain a continuous flow of product. The fact that the molder is the initial producer makes it of vital importance that he be kept in continuous operation throughout the direct working hours of the plant. In order to do this he must either be allowed sufficient space to take an entire day's work, and the molds must be poured by a separate crew, or satisfactory equipment must be installed to handle the sand and the molds away from his center of operation, in order to allow him to keep in continuous production.

Some manufacturers have accepted the first method and have been quite successful. This method calls for a small expenditure for mechanical equipment. It requires only more productive equipment such as flasks, etc. Quite a number of attempts have been made to solve the question along the lines of the second plan.

FIG. 2—MONORAIL DROP-BOTTOM CONVEYOR IN OPERATION OVER ONE OF THE MOLDING SAND BINS AT A MOLDING MACHINE STATION

the core sand introduced into the cycle must be removed. A certain percentage of the molding sand which is burned out in the course of the work must likewise be removed. The practice generally observed shows this quantity to be nearly one ton to each ton of castings produced. This material must be loaded into satisfactory carriers, transported to the yard and disposed of by some satisfactory means, giving three main basic operations in connection with the foundry. Hence a total of 6000 pounds must be handled per ton of castings.

Altogether we have to handle 64 tons of material for each ton of castings produced. These figures do not take into account the numerous small articles which are necessary, neither do they take into account the flasks,

Those who have had large tonnages to make off the same pattern, or patterns which are similar, where the flask equipment was nearly the same size, and where the class of castings could be handled through the same processes without danger of breakage have been quite successful in the installation of the semiautomatic classes of equipment, resulting in the intensive production and practically the progressive plan of manufacture which has been so successful in machine and assembly shops. The fact that they are able to specialize the employe's efforts and concentrate his work on a few simple operations, allows them to use the unskilled laborer to good advantage to replace a more highly specialized mechanic.

The cost of the multistory building is generally conceded by most archi-

tects and engineers to be more economical for the same output than the one-story type, both foundries being operated on a continuous basis. They also have a number of other advantages. Less floor space makes it easier to keep the building in a sanitary condition; also it is more easily ventilated, more easily heated, and more economically lighted. The greatest advantage of the continuously operating multistory foundry is the fact that it may be kept, in continuous operation, producing castings throughout a 24-hour day, which is three times as long as the ordinary foundry, operating under the non-continuous methods, can be kept in production.

The types of continuous foundries which have been developed can be based on the methods of handling materials. In a type which may be called No. 1, the sand is handled and conditioned mechanically, and molds are conveyed to the furnace for the pouring. In type No. 2, the sand is handled and conditioned and the molds set on the floor space, similar to the ordinary practice, while the iron is transported to the molding floor for pouring.

Type No. 1 has its best application where the class of work is practically uniform. Type No. 2 has a much broader application, and can be used on almost any class of light work. Variations from these types occur largely in the method of handling the sand, molds, iron and castings. It is conceded by most engineers, and by practically all foundrymen with experience in the operation of a plant with mechanical sand-handling equipment, that the cost of handling and conditioning the sand is greater where the sand is removed from the floor, conditioned and returned to the molders, than where the sand is conditioned on the floor. It is also generally agreed that sand in most cases is not in as good condition after being handled mechanically as it is when allowed to remain on the floor for a sufficient length of time to give it the benefit of a thorough soaking.

The plants with which the writer has been connected, and also those which he has observed, have as a rule experienced more or less difficulty with the proper conditioning of their sand. The shop operated for the General Motors Corp. at the Buick plant in Flint, Mich., is run on the continuous method. The iron is transported from the cupola to the molding floor. The molds are set on the floor and poured from hand ladles. The molds are shaken out on the molding floor, and the sand passes through a grating to the floor below, where it is allowed to temper in a heap similar to that in any sand heap in an ordinary foundry. It is next picked up by a grab bucket and transported to the sides of the building where it passes through a rotary screen, and is elevated to a hopper in the roof. From this hopper, it is delivered into a drop-bottom monorail conveyor which runs over the tops of the sand hoppers at the molding machines. These sand hoppers have open bottoms from which the sand is shoveled into the molds.

Fig. 1 shows the grab-bucket standing on the monorail over the sand hoppers which receive the sand before it passes through the bottom riddles into the pit which delivers it to the elevator leg that in turn conveys it to the sand hoppers in the roof. Fig. 2 shows the monorail drop-bottom conveyor in operation over one of the molding sand bins at a molding machine station. These bins are 36 inches in diameter, with an open bottom which places the sand in a handy position for the operator. In this particular layout, we have all of the advantages of conditioning the sand which are had in the ordinary foundry. The sand is kept in good condition at all times.

The continuous operation of all units which enter into the cycle are imperative for the successful operation of such an institution. Gravity is taken advantage of by dropping the hot sand through a grating and the castings at the same time are removed to the first floor by being shot down an inclined chute. This inclined chute acts as a reservoir which allows the castings to become cooled to such a condition that they can be handled by hand or other satisfactory means to a truck, and thence are transported to the cleaning room.

The factory is kept in continuous operation for a period of 10 hours. The cupolas are started as soon as the molders enter in the morning, and the bottom is dropped when the molders leave.

To assure continuous production through all the operating cycles it is necessary to balance individual operations with a limited amount of material in process. In the writer's opinion, it is much more economical to carry ample stock at all times than to run the risk of hampering any of the productive operations which act on the final output of the plant. To gain this point, the design of any material handling system requires a factor of safety. This factor of safety should be in the form of accessible storage.

The building construction which has been generally accepted as the most satisfactory has been the reinforced concrete, steel and glass type. The natural tendency has been to locate the initial operation on the upper floor and to use the basement, or grade floor, for later or finishing operations. This tendency as a result has forced the prime operations such as molding and coremaking onto the second floor which is subjected to more or less vibration caused by the handling operations necessary in the foundry. The lack of sufficient foundation for these operations limits the use of jarring machines. This is an item for serious consideration, since the jarring machine is conceded to be most efficient for rapid and accurate production. This objection can be overcome to some extent by framing the floor to allow heavy foundations to be built from the grade. This, too, has its objections, due to the constricted area in which machinery must be located. In blocking out a foundry floor, with certain definite spaces for location of molding machinery, sufficient space must be allowed to operate the particular job, which in a great many cases is too much for another job which must be handled in the same plant. This type of construction is also expensive, and absorbs considerable of the area on the grade floor. Any machinery such as blowers, shafting, or other power apparatus suspended from the ceiling on the grade floor, causes vibrations which result in distortion of delicate green sand cores, and many molds are caused to drop unless additional precautions are taken in each of these individual cases.

No thorough engineer will make a machinery layout for a machine shop or other manufacturing plant without full consideration of the detailed operations in connection with the individual jobs to be manufactured. The variety of specific operations in the production of castings, although the castings may be of the same general type, is so great that they can best be handled by designing machinery and equipment for the individual pattern.

Ample floor space to permit individual, progressive production should be allowed and provision should be made for castings to be poured in a so-called continuous way, which in reality in most cases is in short intermittent periods.

The writer's experience with prime operations on other than the grade floor has convinced him that the possibility of economy is balanced by the added maintenance and operating difficulties. Equal attention should be paid to every material handling operation if the plant is to be run with the greatest economy.

Molders Induced to Use Shower Baths

For the purpose of inducing the molders in its employ to utilize shower baths which had been installed at a considerable expense, a bonus of 25 cents per day was paid by a large foundry in the central west to three molders for a sufficient period to attract the attention of the other employes of this shop and to interest them in personal cleanliness before their return home. Gradually the other employes were attracted to the shower baths which now are being used by nearly all of the men in both summer and winter.

Participate in Standards Committee

The American Society for Testing Materials has voted to participate in the organization of an American Engineering Standards committee and it will be represented on this committee by past presidents A. A. Stevenson, Standard Steel Co., Philadelphia; A. W. Gibbs, Pennsylvania railroad, Philadelphia, and J. A. Capp, chief of the testing laboratory, General Electric Co., Schenectady, N. Y.

The Shepard Electric Crane & Hoist Co., Montour Falls, N. Y., has opened an office in the New Lexington building, Baltimore, to take care of its rapidly increasing business in the south and also to give better service to users of Shepard equipment in that territory. Norman P. Farrar, who was district manager of the Philadelphia territory has been placed in charge of the Baltimore office.

Removing Foundry Dust by Electric Precipitation

Two Sets of Electrodes Used in Cottrell Process, Dust Being Charged With Static Electricity and Attracted to Collecting Electrodes

By H D Egbert

IN copper, lead and zinc smelters and refineries and in chemical works the Cottrell electrical precipitation processes have been recognized for several years and are well established as a standard means for removing finely divided particles of material such as dust, fume, acid mists, etc., from gases. It is only more recently, however, that the use of these processes has been seriously considered as applied to the solution of the dust problems which are present in nearly every manufacturing establishment where grinding, buffing, polishing, sand-blasting or metal cleaning form a part of the operations.

The dust-handling problems connected with sand-blasting and tumbling-barrel operations in iron foundries have long presented many points of difficulty, and it is therefore but natural that interest should have been aroused in the possible application of electrical precipitation to their solution. Already considerable thought has been given and much work done toward adapting the Cottrell processes to this particular field and the results to date are most promising. This paper proposes to deal with the Cottrell processes, with particular reference to their application to foundry dust problems. A description will be given of a typical installation designed to clean the dusty air coming from tumbling barrels in an iron foundry.

Before proceeding, however, to a discussion of what has been done in this particular field with the Cottrell processes, a brief explanation of the fundamental principles underlying the electrical precipitation processes will undoubtedly be of interest and will further serve to make clear the terms used in the descriptions given in this paper.

Electrical Precipitation Principles

A body highly charged with electricity and so shaped as to facilitate the silent discharge through the surrounding air of some of the electrical energy with which it is supplied, will impart an electric charge of the same sign (*i. e.*, negative or positive as the case may be) to any particles of matter which may be in its immediate vicinity. As bodies charged with electricity of the same sign repel each other, all such particles will, if free to move, be violently repelled from the fixed charged body to which the electrical energy is being supplied. This is the principle made use of in electrical precipitation.

The essential elements of a precipitator are two sets of electrodes. One set, known as the discharge electrodes, are of such form as to facilitate an electric discharge from their surface, as for instance a wire, a light chain or a strip of metal having relatively sharp edges, while the other set, known as the collecting electrodes, are of such shape as to prevent as far as possible any discharge from their surfaces, as for instance a flat plate or a pipe with a smooth interior surface.

These electrodes are so arranged in the precipitator that the different types oppose each other and between them a silent or glow discharge is maintained by supplying to the discharge electrode electrical energy of a unidirectional character and at a relatively high voltage. In practice the collecting electrodes are grounded for reasons of convenience and safety, the ground being used as the return portion of the circuit. A typical form of precipitator, for example, consists of a grounded pipe along the central axis of which is suspended a wire connected to a source of unidirectional high voltage electric power.

The air or other gas carrying the suspended liquid or solid particles which are to be removed is passed between the discharge and collecting electrodes. During passage the particles of suspended matter are charged and are driven away from the discharge electrode and over to the collecting electrode, upon which they are deposited. The air or other gases are unaffected and pass on out of

From a paper presented at the annual meeting of American Foundrymen's association, Milwaukee, recently. The author, H. D. Egbert, is associated with The Research Corp., New York.

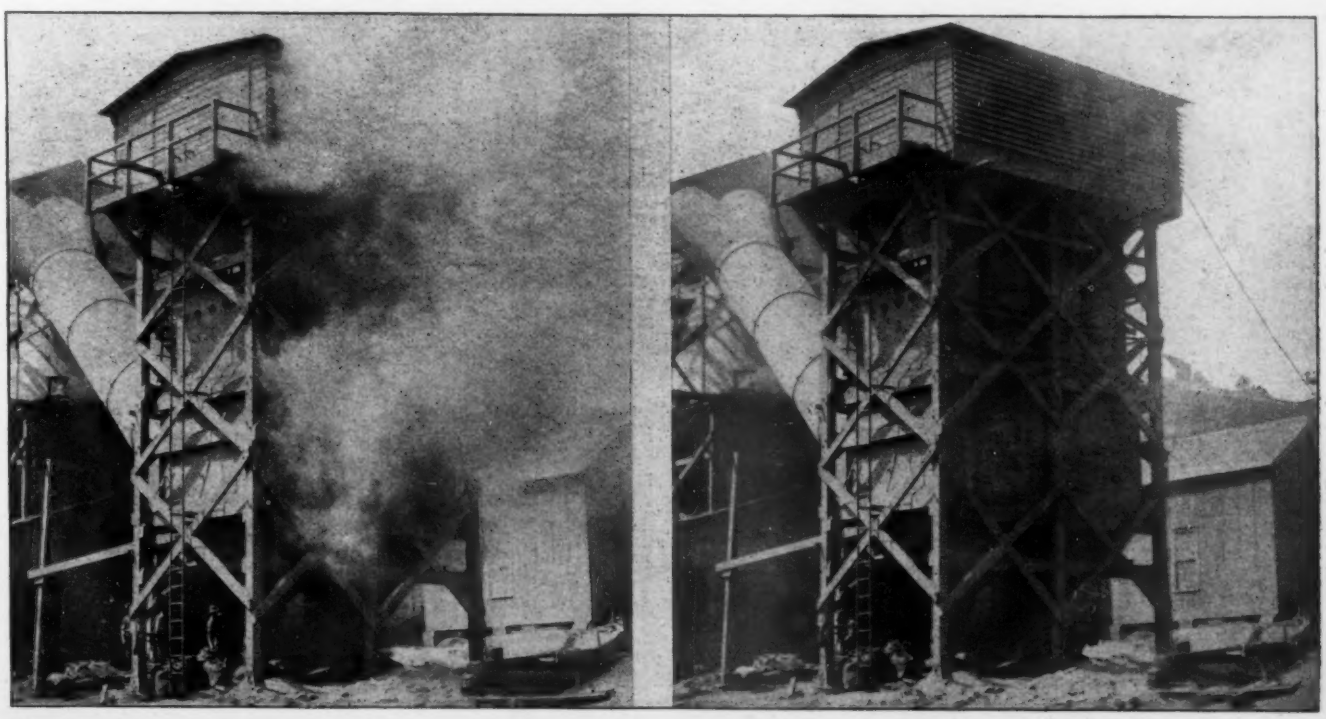


FIG. 1—COTTRELL PRECIPITATOR TREATING AIR FROM SALTE ROCK CRUSHERS—CURRENT OFF. FIG. 2—COTTRELL PRECIPITATOR TREATING AIR FROM SLATE ROCK CRUSHERS—CURRENT ON

the precipitating room or chamber.

It will be evident on slight reflection why high potential alternating current is not used to produce the precipitating effect. This is due to the fact that in such cases the charge on the electrodes rapidly alternates in sign and the particles of matter are alternately repelled and attracted by the discharge electrode and consequently tend to remain suspended in the gas. Alternating current does have an agglomerating effect on the particles, which is particularly noticeable when these particles are liquid in their nature.

If the interior of the precipitator is darkened a glow will be observed emanating from the discharge electrodes, while they are connected to

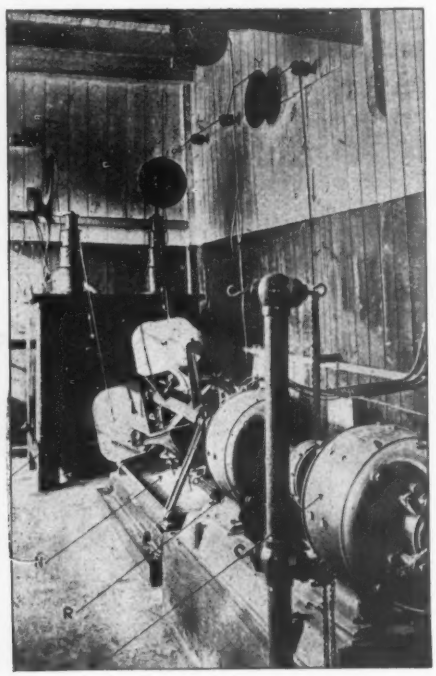


FIG. 3—SET OF ELECTRICAL EQUIPMENT FOR USE WITH ELECTRICAL PRECIPITATION INSTALLATION

the source of high voltage electrical power.

This glow is known as the corona and is an evidence of the intense ionization of the air or other gases surrounding the electrode. For any given gas there is in all cases a rather definite voltage at which a visible corona begins to form depending upon the character of the discharge electrode and the distance or gap space between it and the collecting electrode. The shorter the distance between the electrodes and the smaller the wire or chain used as a discharge electrode, the lower the voltage at which a visible corona will begin to form.

It has been found that the most effective precipitating action is obtained when the potential difference between the electrodes is sufficient to produce a corona discharge and when the discharge electrode is charged negatively rather than positively. The difference in the appearance of the corona when the discharge electrode wire is positively charged and when it is negatively charged is quite marked and when once observed is always easily recognizable. When the wire is positive the corona is seen as a more or less uniform and intense purple glow surrounding the wire. When negative the corona appears as a series of brilliant points of purplish light spaced at rather regular intervals along the wire.

The voltage employed in a given precipitator depends upon the size and type of discharge electrode used, the gap distance betweeen the discharge and collecting electrodes and the temperature and other characteristics of the gas being treated. There is a definite relation between the velocity of the gases through the precipitator and the length of the path between the electrodes, in other words the particles must be under the influence of the electric field for a suitable period of time to secure satisfactory removal of these particles from the gases. The length of this period depends to a considerable extent upon the character of the particles to be precipitated. If the particles are fluffy in character, light, dry and finely divided a longer time will be required than if they are relatively heavy or coarse or of a liquid or sticky nature. The length or height of the precipitator is, of course, limited by considerations of practicability and cost and consequently there is in every case a definite limit to the gas velocity through the precipitator at which complete removal of the suspended particles can be accomplished.

Velocity is a Factor

In practice it is common to use collecting electrode pipes ranging from 6 to 12 inches in diameter and from 6 to 15 feet in length, and gas velocities ranging from 6 to 15 feet per second, depending upon the factors just mentioned. It is usual to construct the precipitation installation in sections of units. Such an arrangement may cost somewhat more than a single unit or section, but it has the advantage of allowing considerable flexibility in the operation of the precipitator and permits of a closing down of a portion of the installation for repairs or cleaning without involving the removal of the entire precipitator from service. When the volume of air or gas to be treated is liable to vary at different periods of time this sectional arrangement of the installation has the further advantage of permitting a saving in power by shutting down certain sections of the precipitator at those times when the maximum gas volume does not have to be cleaned.

If the collected material is liquid in nature it will, of course, trickle down the surface of the collecting electrodes and will drop into a suitable container provided for the purpose beneath the precipitator. In such cases the precipitator is self-cleansing. If the collected material is dry or at all sticky in nature it is often necessary to dislodge it from the electrodes by mechanical means. Usually the cleaning is accomplished by striking or rapping the pipes or plates whereupon the collected material falls into hoppers placed beneath the precipitator to receive it. In some cases it is also necessary to clean the discharge electrodes occasionally, and when such a condition is anticipated provision is also made for rapping the framework which supports the high tension or discharge electrodes.

The power consumption of an electrical precipitator is governed by the number of electrodes and their length, type and size, as well as by the characteristics of the gases to be cleaned as regards temperature, conductivity, etc. The power consumption, however, is in no cases excessive and is usually quite small. For example, a precipitator for cleaning 10,000 cubic feet of gas or air per minute will usually require no more than 7 to 10 kilowatts.

A short description of the method commonly used to obtain the high potential unidirectional current re-

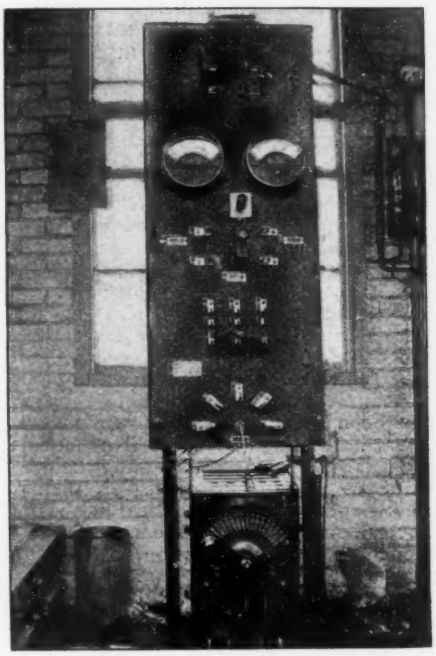


FIG. 4—SINGLE-PANEL SWITCHBOARD FOR USE WITH ELECTRICAL PRECIPITATION INSTALLATION

quired by the precipitator will doubtless be of interest. This equipment is, of course, more or less special in its nature and is particularly designed for use in precipitation work. Care must be taken in each case to choose equipment of the proper size and type for each particular installation.

If low tension alternating current of any commercial frequency is available at the plant in which the precipitator is installed, all that is required in the way of electrical equipment is a transformer of proper capacity for stepping up the low tension electric current to the required voltage for use in the precipitator; a rectifier for changing the high voltage alternating current into high voltage unidirectional current and a small switchboard panel with the necessary instruments, circuit breaker, rheostat, etc., mounted upon it. A 2 to 3-horsepower synchronous motor is also required for driving the rectifier in synchronism with the alternating current supply.

If only direct current is available at the plant in question it is necessary to install a small motor-generator set for the purpose of producing the

low tension alternating current. The remainder of the equipment is the same as in the previous case, with the exception that the rectifier instead of being provided with a separate synchronous driving motor is driven by the motor-generator set and directly connected to it by means of a flexible coupling.

Fig. 3 shows a typical set of electrical equipment for use with a Cottrell precipitation installation. This apparatus consists of a motor-generator set, rectifier, transformer and switchboard panel. As mentioned, in case a steady supply of alternating current is available at the plant a small synchronous motor can be substituted for the motor-generator set here shown, thus reducing considerably the cost of the electrical equipment.

Switchboard Layout

Fig. 4 shows a typical single-panel switchboard for use with a single set of electrical equipment, such as is employed with a moderate sized installation of the Cottrell processes. At the top of the switchboard will be seen a circuit breaker which operates to disconnect the synchronous motor if short circuits occur anywhere in the precipitator or in other portions of the high tension or low tension circuits. Beneath the circuit breaker will be seen the ammeter and voltmeter which are connected in the low tension circuit of the transformer. Below these meters is a switch, also in the low tension circuit to the transformer, which permits disconnecting the primary windings of the transformer from the power supply circuit. Below this switch on the board is a multiple-point switch which connects the various taps brought out on the primary or low tension side of the transformer. By changing the position of this switch the secondary voltage delivered by the transformer may be varied at will within certain fixed limits.

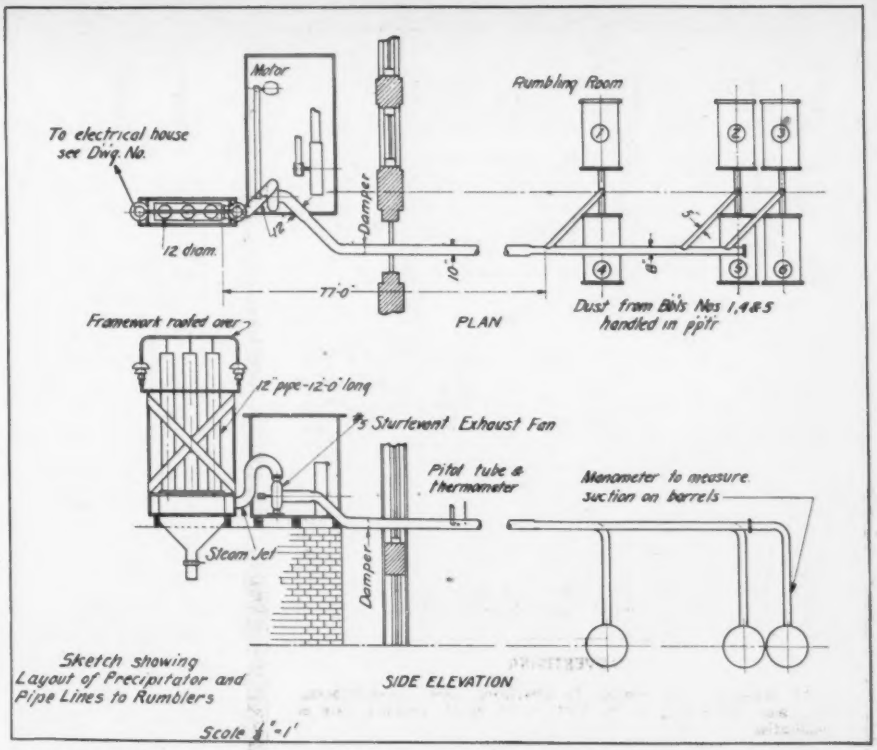


FIG. 6—ARRANGEMENT OF TEST INSTALLATION TO TREAT AIR FROM FOUNDRY TUMBLING BARRELS

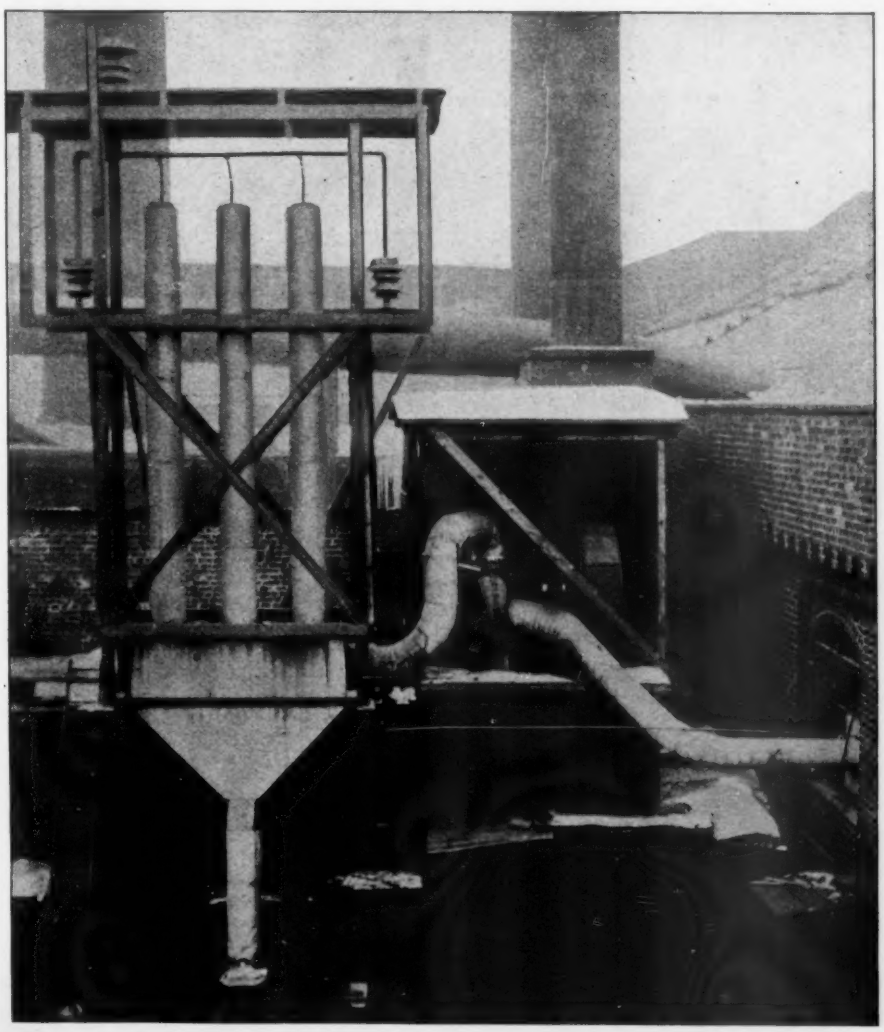


FIG. 5—TEST PRECIPITATOR TREATING AIR DRAWN FROM FOUNDRY TUMBLING BARRELS

Tests in a Foundry

Several months ago an exhaustive series of tests were made with the Cottrell processes on dust laden air drawn from tumbling barrels in a large iron foundry near New York City. These tests demonstrated that an electrical precipitator could successfully remove and collect all the dust carried by the air from these tumbling barrels under various conditions of operation.

Fig. 5 is an illustration of the precipitator which was installed in connection with these tests. The collecting electrodes consist of three sheet iron pipes 12 inches in diameter and 12 feet long erected on a bottom header box provided with a hopper and spout for the removal of the collected material. For discharge electrodes, No. 10 jack chain was used suspended along the vertical axis of each pipe. The dust-laden air was drawn from the tumbling barrels used in the tests by means of a motor-driven centrifugal fan located near the precipitator, as shown in the illustration.

It was found that this precipitator could clean the air drawn from three tumbling barrels, the fan being operated so as to maintain a suction head of 2¼ to 3 inches on each barrel. For the particular conditions

(*Concluded on page* 48)

THE FOUNDRY

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Foundry Trade in Retrospect

DURING the year the foundry industry has passed from a war to a peace basis and has patriotically and satisfactorily responded to the needs of the readjustments necessary to meet these two extreme conditions. Much-needed price control of iron and steel products was invoked by the government during the last quarter of 1917, resulting in reductions in the quotations for No. 2 foundry iron of approximately $20 a ton. This had a stabilizing effect on the market and enabled foundrymen to figure on their pig iron needs with a greater degree of certainty than at any time since the beginning of the war. However, government regulation did not end with price control. The war requirements mounted by leaps and bounds until it became necessary to restrict the production of nonessentials. This curtailed the production of stove, hardware and automobile casting plants and to further insure the restriction of output, pig iron deliveries were cut off of these foundries and were allocated to works engaged in the manufacture of production to meet the war needs of the country. Since the requirements of the ordnance departments of the army and navy were so largely for steel castings, these plants were flooded with business and many new steel casting enterprises were launched to take care of the overflow. Never before in the history of the trade has the steel casting industry been so actively or so profitably engaged. Malleable iron manufacturers, on the other hand, did not enjoy as much prosperity as in 1917, nor was the output so large. This was due to the long-deferred railroad buying and the limited amount of malleable iron specified by the government when it finally placed orders for freight cars. While millions of hand and rifle grenades were made of malleable iron, the tonnage involved was not large and before the hand grenade program was well under way, gray iron was substituted for malleable iron. Notwithstanding the curtailment of the gray iron output by the nonessential list, the foundrymen engaged in this branch of the industry enjoyed a fairly active and profitable year. The machinery shops received large orders for castings for all kinds of equipment and many were busily engaged in the production of parts for ship machinery. Accumulated stocks of pig iron and scrap enabled many of the nonessential gray iron plants to operate for months after their pig iron supply was cut off and they suffered little in the interim between the exhaustion of their metal supply and the resumption of shipments immediately after the armistice was signed. Unfortunately the gray iron plants did not have an opporutnity to figure as conspicuously in carrying out the semisteel shell program as would have been the case if the specifications had been completed sooner and the government needs known at an earlier date. Even after the program had been adopted the placing of contracts was deferred and before shipments could be made to the western front the war was at an end. However, it was fortunate that only a few shops were on a production basis and therefore, many plants that otherwise would have been engaged in making cast projectiles, have had an opportunity to swing over to a normal basis without much readjustment. Brass foundries enjoyed a year of great prosperity and since almost all of their work was received from government contractors and subcontractors, they are not directly involved in the settlement on work in process and cancelled orders.

Personal

Richard A. Watson has resigned as secretary and production manager of the American Bronze Corp., Berwyn, Pa.

Paul A. Dratz, Chicago representative of the Whiting Foundry Equipment Co., Harvey, Ill., has resigned to engage in other business.

L. C. Sprague has been appointed assistant secretary of the Chicago Pneumatic Tool Co., Chicago, with headquarters at 52 Vanderbilt avenue, New York.

John McConnell has resigned his position as metallurgical adviser for the United Alloy-Steel Corp., Canton, O., and has taken charge of the production of alloy steel for the Interstate Iron & Steel Co., Chicago.

G. R. Brandon, formerly vice president and engineer of the Whiting Foundry Equipment Co., Harvey, Ill., and who until recently was connected with the Chicago office of this company, has resigned.

Leonard W. Smith, formerly in charge of the copy and planning department of the Dunlap-Ward Advertising Co., now is affiliated with the Powers-House Co., advertising engineers, Illuminating building, Cleveland.

W. C. Wright of the National Founders association delivered an illustrated talk at a recent meeting of the New England Foundrymen's association in Boston on the subject of machine molding.

Norman P. Farrar formerly in charge of the Philadelphia office of the Shepard Electric Crane and Hoist Co., Montour Falls, N. Y., has been made manager of the newly established office of that company at Baltimore.

W. F. Keckeisen has joined the staff of Russell T. Gray, advertising engineer, First National bank building, Chicago. Mr. Keckeisen formerly was advertising manager of the International Filter Co. and previously was associated with the Federal Sign Co.

C. C. Chapel, formerly affiliated with the Hercules Gas Engine Co., Evansville, Ind., and subsequently associated with the Waterloo Gas Engine Co., Waterloo, Iowa, has been appointed superintendent of the foundry that is being erected by the Montgomery, Ward Co. at Springfield, Ill.

H. C. White who has been actively engaged during the last three years in the reorganization of the plants of the Holt Mfg. Co., at Stockton, Cal., and Peoria, Ill., has been appointed factory manager of the plant of the Harris Mfg. Co., builder of harvesters, Stockton, Cal.

Gordon I. Lindsay has been elected president of the Robeson Process Co., 18 East Forty-first street, New York, manufacturer of liquid core binders. He also has been elected president of the American Gum Products Co., 200 Fifth avenue, the same city. For several years Mr. Lindsay has been general manager of the American Gum Products Co.

Frank D. Carney, formerly superintendent of the Pennsylvania Steel Co. and general metallurgist of the Bethlehem Steel Co., and Lewis B. Lindemuth, formerly assistant superintendent of the bessemer open hearth department of the Pennsylvania Steel Co. and superintendent of the electric furnace and crucible departments of the Bethlehem Steel Co., have formed the partnership of Carney and Lindemuth, consulting engineers and metallurgists, with offices at 40 Wall street, New York.

Pittsburgh Foundrymen Hold Christmas Entertainment

The December meeting of the Pittsburgh Foundrymen's association, held Monday, Dec. 16, at the Pittsburgh Athletic association, was featured by a Christmas entertainment. This affair had the largest attendance of any similar event in the history of this organization, approximately 350 foundrymen having been present. The dinner was followed by an address by A. O. Backert, president of the American Foundrymen's association. Following Mr. Backert's address, an aquatic exhibition was given in the swimming pool of the clubhouse and this was followed by a number of amateur boxing bouts. The entertainment committee in charge of this Christmas celebration consisted of J. S. McCormick, chairman, J. S. McCormick Co.; W. W. Sanderson, Carborundum Co.; C. W. Howat, Union Steel Casting Co. and T. E. Malone, J. S. McCormick Co. The entertainment was unique and reflected great credit upon the entertainment committee.

A Story of Modern Industrial Relations

The numerous activities fostered by the American Cast Iron Pipe Co., Birmingham, Ala., for its large number of employes, both white and colored, are described in an interesting manner in a 72-page monograph on this subject. This story of modern industrial relations reflects that biblical quotation, namely, "Behold, how good and how pleasant it is for brethren to dwell together in unity." That every effort has been made to achieve the spirit of the foregoing sentiment is reflected by the many activities of this company for the welfare of its employes and their families. The problem at this plant was the more difficult of solution because of the employment of large numbers of both white and colored men, yet the activities of both are parallel, but entirely separate. Many valuable suggestions may be obtained from this book by manufacturers who are contemplating, or who already have undertaken various welfare activities.

Whiting Foundry Equipment Co. Announces Changes

The Whiting Foundry Equipment Co., Harvey, Ill., announces the following changes in its organization: Samuel Moore, formerly general manager of the Bond plant of the American Radiator Co., Buffalo, succeeds F. A. Rundle as general superintendent; C. A. Hardy has resigned as sales manager; George Ristine, formerly affiliated with the Pressed Steel Car Co., Pittsburgh, and H. A. Wolcott, formerly with the McMyler Interstate Co., Cleveland, and E. V. Brown, and Walter R. Hans, members of the company's engineering staff, will be the Chicago representatives of the Whiting Co., succeeding G. R. Brandon and Paul A. Dratz.

Death of E. C. Anderson

E. C. Anderson, affiliated for many years with the Thomas E. Coale Lumber Co., Philadelphia, in the sale of pattern lumber, died at his home in Philadelphia on Nov. 10. Mr. Anderson was assistant to the president of the Coale company and was widely known throughout the foundry and patternmaking trades. He is survived by his widow and three sons. A. W. Anderson, who was associated with his father in the pattern lumber business for the last few years, under the supervision of Thomas E. Coale, will continue to look after his father's trade.

Rich Foundry Equipment Co. Succeeds Brown Specialty

The firm name of the Brown Specialty Machinery Co., Chicago, manufacturer of sand-blast equipment, core machines and sand shakers, has been changed to that of the Rich Foundry Equipment Co. The Brown Specialty Machinery Co. was incorporated in 1901 by Edwin F. Brown, and was purchased by Elmer A. Rich Jr., in 1912. Since that time this company has engaged exclusively in the manufacture of foundry equipment, such as core machines, sand shakers, sand-blast equipment and malleable annealing room charging trucks. The change in the firm name involves no change in the management or in the conduct of the business.

Will Place Technically-Trained Soldiers

America's great assets, the brain power and energy of thoroughly trained young men, are the commodities in which the professional division of the United States employment service is dealing. Officers and men of the army and navy released from active service are being registered with the division and will be placed in touch with those employers who can best make use of their services.

This agency of the government deals only with those who are well equipped by education and experience in their particular lines of work. The record of each man is carefully investigated before registration is permitted. Many university graduates in mechanical, electrical and civil engineering, and in chemistry, and other technical men with several years of practical experience, have already been registered. These men who willingly severed their business relations more than a year ago to give their services to their country are returning to civil life and desire to re-enter industry.

The professional division has its New York office at 16 East Forty-second stret. Employers seeking such men as it lists are asked to inform the division of the precise nature of the positions which they have available. Only those men who are well qualified to fill such positions will be referred to the employer.

New Uses for Fire-Proof Plastic Cement

Errosion and high temperatures reduce the life of ladle, runner and cupola melting zone linings. Daily patching, and in some cases repairs following each heat in the case of the ladles and spouts are required to handle safely the molten metal. To lessen the frequency of repairs, the Quigley Furnace Specialties Co., New York, has adapted its high temperature firebrick cement to the purposes of bonding and repairing fire clay or silica brick work about the various types of furnaces.

In using this cement in cupolas, the slag in contact with the bricks of the melting zone is first removed. A primary coating or patch of one-half old crushed fire brick and one-half of the cement is then applied and allowed to dry by action of the air. A plastic coating, about ½-inch in thickness, composed of two-thirds silica sand or crushed crucibles and one-third of the special cement is then applied and allowed to dry. The cupola may then be fired as usual. When the slag is removed from the cupola, some of the outer coating may be pulled away, but the inner surface is said to remain firmly in place and only the outer portion must be replaced.

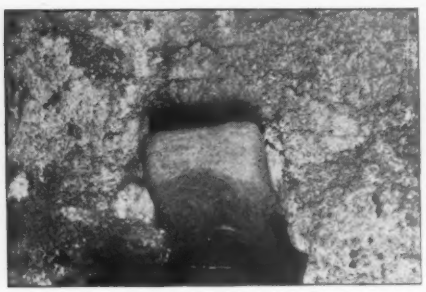


FIG. 1—POURING SPOUT OF CUPOLA LINED WITH PLASTIC CEMENT INSTEAD OF FIRE-CLAY

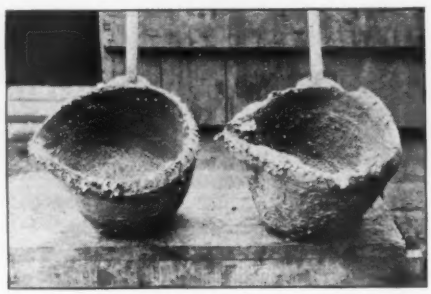


FIG. 2—THE LADLE AT THE LEFT WAS LINED WITH THE CEMENT, THE ONE AT THE RIGHT WITH FIRE-CLAY

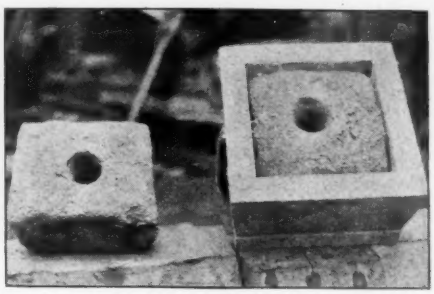


FIG. 3—BREAST BRICK FOR CUPOLA IRON NOTCH, MOLDED FROM PLASTIC CEMENT REQUIRES NO DRILLING

The advantages claimed for this material in lining pouring spouts include a longer life without renewal and less crumbling under the wash of molten metal. Fig. 1 shows a runner lined in the manner outlined. Fig. 2 illustrates two 40-pound ladles; the one at the right was lined with fire clay and the one at the left with the plastic fire-proof cement. Fig. 3 indicates the methods of making a breast brick for the spout, which is ordinarily made by drilling a brick to set into the pouring opening of the cupola.

Removing Foundry Dust by Electric Precipitation

(*Concluded from Page* 45)

met with at the plant in question this suction head on the tumbling barrels seemed to give best results both as regards the time required for tumbling and the satisfactory cleaning of the castings. The volume of air handled by the test precipitator under these conditions averaged about 1100 cubic feet per minute at a temperature of 63 degrees Fahr., so that each pipe was cleaning approximately 366 cubic feet of air per minute.

Fig. 6 gives in plan and section a a diagrammatic layout of the test precipitator and its connections to the tumbling barrels.

During the tests measurements were made to show the amount of dust coming from the barrels at various times in the cycle of operation. It is interesting to note that practically 65 per cent of the dust was caught in the first half hour following the starting up of the tumbling barrels on a new batch of castings. Thereafter the amount of dust carried in suspension in the gas dropped off rapidly until after one hour the dust content became practically constant and remained nearly so until the end of the tumbling period.

Based on the results obtained from these tests a precipitation installation to clean approximately 22,000 cubic feet of gas per minute has been designed. The precipitator consists of three sections or units, each with 36 collecting electrode pipes or tubes 8 inches in diameter and 15 feet in height. The recent tendency in electrical precipitation work has been toward collecting electrode tubes of smaller diameter, as it has been found that with the smaller pipes somewhat better efficiency with a lower operating voltage can be obtained. In the present design, therefore, collecting electrode tubes 8 inches in diameter rather than 12 inches have been employed, and the operating voltage will be approximately 65,000 to 70,000 volts.

To secure uniform distribution of the dusty air among the several collecting electrode pipes, the air is admitted some distance above the bottom of the pipes so that it passes down around these and then up between the electrodes and so into the top header, whence it is discharged to the open air.

The collecting electrode pipes are of No. 16 gage sheet steel while the supporting structure as well as the bottom and top headers and hoppers are timber. One set of electrical equipment is provided to furnish the current for all three precipitator sections. This set, which is to operate on a 440-volt, 3-phase, 60-cycle power line will consist of a 25-kilovolt-ampere transformer having a maximum secondary voltage of 75,000 volts; a mechanical rectifier driven by a 3-horsepower, 3-phase, 1800 revolutions per minute synchronous motor, a switchboard with the necessary instruments, circuit breaker, rheostat, switches, etc. It is estimated that the entire installation as shown, exclusive of any engineering or license fee, will cost in the neighborhood of $11,000, exclusive of the cost of any flue connections from the exhauster to the precipitator.

Rapping hammers or knockers can be arranged to operate automatically through a motor-driven mechanism, or as is more usually the case, they can be operated by hand, especially if the intervals between the rapping periods are not too short.

Figs. 1 and 2 illustrate graphically what the Cottrell processes can accomplish in the way of dust collection. The precipitator shown handles air drawn from slate rock grinders or crushers at a plant in Vermont. Fig. 1 shows the precipitator with the electric current turned off, while Fig. 2 shows the same precipitator after the current has been turned on. The heavy dust content of the air which the precipitator is obliged to clean is well shown by the clouds of dust coming out of the top header of the precipitator in Fig. 1, when the installation is not in operation, and the effective cleaning of the air is clearly shown by Fig. 2. This precipitator handles some 35,000 cubic feet of gas per minute, and has been in continuous operation for nearly three years. This installation has recently been enlarged and will shortly be handling a total of nearly 100,000 cubic feet of air per minute.

For the Cottrell processes of electrical precipitation several advantages are claimed which make them particularly adaptable for dust cleaning work in factories and foundries. In the first place, the dust can be collected satisfactorily, no matter in how finely a divided state it may be. Secondly, the danger of fire can be eliminated since the precipitator can, if so desired, be built entirely of sheet metal. Likewise the gases can be treated at any temperature up to 1000 degrees Fahr.

Importance of the Band-Sawing Machine

By M. E. Duggan

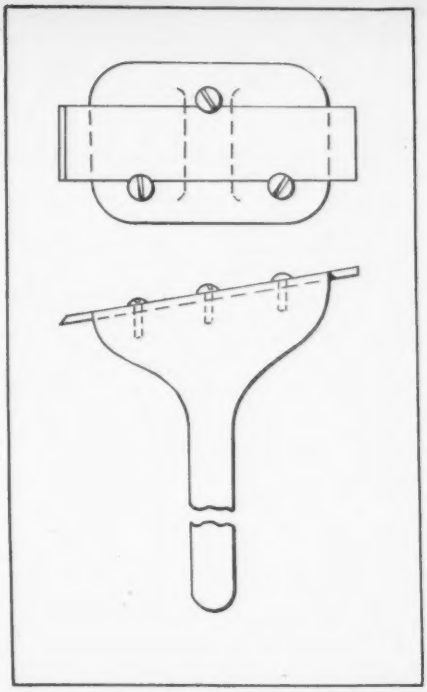
One of the most important pieces of equipment in the pattern shop is the band-sawing machine, as it performs its operations with great speed and serves the purpose of the circular saw and also in a limited way, the jig saw. One of the greatest

advantgaes of the band saw is the fact that it will cut true and exact to line, which is exceedingly valuable in making gear teeth, cutting segments, etc. The table is adjustable for cutting bevels. In practically all pattern shops a large amount of work is done by hand that could be performed more advantageously by the band-sawing machine, providing this equipment is in good working condition. However, it cannot be said that the equipment in many pattern shops is kept in good operating condition.

What I mean by good operating condition is best answered by detailing the band-saw upkeep in a pattern shop where I am now employed. More than a year ago a new band saw was purchased as well as saws of the following sizes: Three ¼-inch, three ⅜-inch, one ½-inch and one ⅝-inch. Since these saws were purchased, none above the ¼-inch size has been used and as soon as a saw gives indications of being dull, it is replaced by one that is sharp. Only two saws were broken during this period and these were sent to the saw factory to be repaired, which I believe is the only place a saw can be repaired properly. Good work cannot be done with a saw that has three or four splices, particularly if the splicing has been done by a so-called handy-man.

With a sharp ¼-inch saw I can cut exact from zero to 13 inches deep either along a straight line or in a circle and when I have finished sawing the piece, it is ready to be sand-papered. This is the result of keeping the band saw in good condition. It might be added that this is difficult to do in a large shop where a great many patternmakers are employed. I have never been able to discover why only one band-saw is provided in shops employing 15 to 20 patternmakers, to say nothing about the workmen in other departments who utilize the saw from time to time. I am sure that in the not distant future, band saws of smaller sizes will be built and these will be conveniently located about the plant.

In our shop it is the duty of an apprentice boy to clean and lubricate every moving part of the band-sawing machine. By moving part I mean not alone the loose pulley which in a great many instances is the only part that receives attention, but also the shifter rod, the counterweight pulley, the vertical sliding bar to which the saw guide is fastened and the guides as well.



GLUE SCRAPER MADE FROM AN OLD FILE

An Inexpensive Glue Scraper

By S. L. Cook

The glue scraper shown in the accompanying illustration possesses many advantages that will be readily recognized by the patternmaker. It can be made quickly of materials to be found in any pattern shop. The handle is wood and should be about 6 inches long. The angle at the end should be approximately 10 degrees. The blade is made from a piece of an old file that has not been annealed. To make the blade, all that is necessary is to break off a piece of the desired length and grind one end, as shown in the illustration. The blade fits in a slot in the handle that should be provided for this purpose. Three No. 8, ¾-inch wood screws are used to hold the blade firmly in place.

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

The United Iron Works & Machine Co., Haileybury, Ont., is looking for a site for a foundry.

The Filer & Stowell Co., Milwaukee, has a permit to build a foundry addition, 71 x 130 feet.

Fire in the Gibby Foundry, Condor street, Boston, caused a heavy loss.

The plant of the Beaver Foundry Co., St. Johns, Oreg., recently was damaged by fire.

The United Iron Works & Machine Co., Ltd., is having plans prepared for the erection of a foundry.

The Universal Tool Steel Co., Defferin street, Toronto, Ont., is erecting a foundry addition.

The National Iron Works, Cherry street, Toronto, Ont., is building a foundry addition.

The Nazareth Foundry & Machine Co., Nazareth, Pa., is enlarging its foundry.

The Vulcan Iron Works, Jersey City, N. J., contemplates alterations to its foundry.

The Magnus Metal Co., New Haven, Conn., plans the erection of a foundry extension, 16 x 94 feet.

The H. W. Clark Co., Mattoon, Ill., is rebuilding its foundry and metal works.

The Gier Pressed Steel Co., Lansing, Mich., is building a foundry, 98 x 200 feet.

The Chisholm & Moore Co., 5046 Lakeside avenue, Cleveland, has awarded a contract for the erection of an addition to its foundry, 34 x 60 feet.

The McLaughlin Foundry Co., Decatur, Ill., contemplates the erection of an addition.

G. W. Nelson, Superior, Wis., has established a brass foundry in the old plant of the Acme Brass Foundry.

The McKim Foundry & Machine Co., Lockport, N. Y., recently increased its capital from $200,000 to $1,500,000.

D. Balkansky, Ninth and Huron streets, Manitowoc, Wis., plans the erection of an addition to his foundry.

The East Liverpool Foundry Co., East Liverpool, O., will move its plant to Jeannette, Pa., where it will have larger quarters.

The Camden Iron Works, Camden, N. J., has filed plans for the erection of a foundry, 90 x 127 feet, at Line and Perry streets.

An extension to the foundry of the Pratt & Whitney Co., 436 Capitol avenue, Hartford, Conn., is under way.

Work is going forward on a foundry and machine shop at the Charlestown, Mass., navy yard. The building is to be 20 x 256 feet.

The Cambridge Foundry & Machine Co., Cambridge, O., has purchased the plant of the Robert Ford Co. and will remodel it for an addition to its plant.

O. J. Cavanaugh & Co., Tilbury, Ont., will start work soon on the erection of a foundry. N. Girus is general manager.

The Hesse-Martin Iron Works, Belmont and East Seventh streets, Portland, Oreg., has had plans prepared for the erection of an addition to its foundry.

The International Harvester Corp., Chicago, is building a new foundry at its Plano Works, West Pullman, Ill.

Plans are being drawn for the erection of a foundry, 40 x 100 feet, for the H. & H. Foundry Co., Stamford, Conn.

The International Castings Co., Sandwich, Ont., Canada, is building a foundry to manufacture gray iron and semisteel castings.

The Detroit Piston Ring Co., Richmond avenue, Detroit, manufacturer of piston rings, is building a new gray iron foundry.

The Kedzie Foundry Co., 3234 West Thirty-fourth street, Chicago, has had plans prepared for the erection of a foundry, 46 x 60 feet.

The Pittsburgh Foundry Co., 4801 South Alameda street, Los Angeles, will build an addition, 50 x 125 feet.

The Mid West Brass Co., North Aurora, Ill.,

plans to rebuild its foundry which was recently damaged by fire.

The Manitoba Steel Foundry Co., Mapleton, Man., will soon start on the erection of an addition.

The Gerlinger Steel Castings Co., Fifty-ninth street and National avenue, Milwaukee, is building a foundry addition, 80 x 184 feet.

The Funkl & Son Co., 1990-94 Kingsbury street, Chicago, has awarded a contract for the erection of a foundry, 65 x 90 feet.

The Camden Iron Works, Line and Ringgold streets, Camden, N. J., plans to rebuild its pattern shop, which was recently badly damaged by fire.

Fire recently damaged the foundry of the Greenmount Iron & Mfg. Co., 883 Greenmount avenue, Baltimore.

The Palmer Foundry & Machine Co., 27 Foundry street, Palmer, Mass., is building an addition, 75 x 120 feet.

The Finkel Bros. Co., Cortland street, Chicago, contemplates the erection of an addition to its foundry on Kingsbury stret.

The New Orleans Boiler Works, New Orleans, plans to equip three new buildings for foundry and machine shop use and is now taking bids on machinery.

The plant of the Pilsen Foundry & Iron Works, 1530 West Thirty-second street, Chicago, recently was badly damaged by fire.

The Simms Foundry Co., Racine, Wis., has awarded contracts for the erection of an addition, 60 x 85 feet.

The Standard Foundry Co., Racine, Wis., contemplates the erection of an addition, 80 x 200 feet. The contract has been let to Nelson & Co., Racine.

The brass foundry of Louis Blumberg, 333-34 North Fourth street, Philadelphia, recently was badly damaged by fire.

The American Car & Foundry Co., J. M. Buick, general manager, Syndicate Trust building, St. Louis, is drawing plans for a new plant at East Gary, Ind.

Bids are being taken for the erection of a foundry addition for the Missouri Malleable Iron Co., East St. Louis, Ill. The building will be 23 x 150 feet.

The Hancock Foundry & Machine Co., New Cumberland, W. Va., contemplates the erection of an addition, 60 x 120 feet.

The Mahoning Foundry Co., Youngstown, O., expects to start work soon on the erection of a foundry, 120 x 200 feet.

The Hoffman Bronze Co., 1000 Addison road, Cleveland, has let a contract for the erection of a foundry, 21 x 101 feet.

The foundry of the Hessler Foundry & Machine Co., Oswego, N. Y., recently damaged by fire, will be rebuilt. Bids are now being taken.

The Crompton & Knowles Loom Works, Grand street, Worcester, Mass., has postponed the erection of a foundry addition until spring. F. A. Dadmun, 93 Grand street, is engineer.

C. W. Parks, of the bureau of yards and docks, Washington, D. C., has had plans prepared for the erection of a machine shop and foundry at the Charlestown navy yard.

The Corbet Foundry & Machine Co., Ltd., Owen Sound, Ont., is in the market for electric motors, one of 10 and one of 5-horsepower capacity, 550 volts, 60-cycle, 3-phase.

The Western Iron Works, Anacortes, Wash., is constructing the foundation for a temporary foundry and machine shop building, 80 x 96 feet. Next summer permanent shops and foundries will be erected.

The Michigan Press Co., Ypsilanti, Mich., recently purchased the foundry of the Plymouth Motor Castings Co., Plymouth, Mich., and will operate it as a gray iron shop.

The Standard Auto Signal Co., Engineers building, Cleveland, has obtained a permit to erect a foundry, 32 x 72 feet. The contract has been let to James Mitchell, 15516 Hilliard avenue, Cleveland.

The Southern Brass Works, Portsmouth, Va., has awarded a contract to John W. Hoffler, 504 Fifth avenue, for the erection of a plant addition, 40 x 67 feet.

The Lewin Metals Corp., 23 Branch street, St. Louis, has started work on the erection of a foundry.

The Metal & Alloy Specialty Co., 25 Illinois street, Buffalo, has abandoned its project of erecting a foundry, and has purchased a building which will be equipped for an aluminum and brass casting plant.

The Keller Mfg. Co., 1325 Quincy street, Minneapolis, Minn., is having plans prepared for the erection of a foundry, 50 x 100 feet. P. A. Crosier, 4337 Twelfth avenue is architect.

The U. S. Copper Products Corp., Guardian building, Cleveland, has started on the erection of the first unit of its copper and brass plant, which will include a foundry department.

The Empire Machine Works, Terre Haute, Ind., contemplates the erection of a brass foundry and is in the market for equipment, including brass furnaces, core ovens, flasks, molding machines, etc.

The Otto Biefeld Co., 202 North Water street, Watertown, Wis., contemplates the erection of a foundry building. The project is expected to mature in the spring.

The Hercules Gas Engine Co., Evansville, Ind., which is building a new foundry, has decided to defer the purchase of new equipment for several months.

The Swayzee Gray Iron Foundry Co., Swayzee, Wash., has been incorporated with $15,000 capital by Cyrus Foltz, Sanford D. Morrison and Lloyd Morrison.

The Three Rivers Steel Foundry, Ltd., Three Rivers, Que., will make alterations to its plant and will install additional machinery. A. B. Charlton is general manager.

The plant of the Charles E. Davis Foundry Co., Rutland, Vt., recently was badly damaged by fire. The pattern and core rooms suffered the heaviest loss.

Plans have been completed for a foundry extension to the plant of the Atlas Steel Casting Co., 1963 Elmwood avenue, Buffalo. The addition will be 50 x 112 feet.

The New Brassware Co. of Canada, Ltd., Montreal, Que., recently was incorporated with $10,000 capital to carry on the business of brass founders, etc. The incorporators were Charles Levesque, Joseph L. Labrose, Simon Labrose and others, of Montreal.

The Stuart Foundry Co., Detroit, recently organized with $100,000 capital stock, plans to erect a plant. A. W. Semplinen, 2005 Dime Bank building and others are the incorporators.

The Royal Machinery & Foundry Co., Oshkosh, Wis., has been incorporated to manufacture metal specialties, with $30,000 capital by F. C. Clark, Peter P. Schloemer and Robert B. Hainsworth.

John Jarvey, care of the Semo Steel Test Foundry Co., 4916 Bloomingdale avenue, Chicago, plans the erection of a foundry, 49 x 85 feet. Thomas Mulay, 179 West Washington street, is architect. Bids will be taken in the spring.

The Nash Motors Co., Kenosha, Wis., is enlarging its core department by the erection of a new building, and the structure now occupied by this department will be utilized for extending the capacity of the gray iron foundry.

NEW TRADE PUBLICATIONS

FACTORY BUILDINGS.—A handsomely illustrated 64-page catalog, issued by the Austin Co., engineers and builders, Cleveland, describes the Austin method of standard factory building construction. This method is described as one by which permanent and substantial factory buildings are erected in the fewest number of working days by eliminating delays otherwise unavoidable and by standardization and quantity production. This method provides for various industrial types of construction by standardized designs and specifications and, therefore, the time ordinarily required for preparation of special plans is saved. Stocks of fabricated steel, steel sash, roofing, lumber and other materials involved in pre-construction work are held at strategic points and may be delivered promptly to any job in any part of the country. The speed with which buildings may be erected by this method is marvelous and reference is made to a record of providing material for 540,000 square feet of buildings on one job in 55 calendar days. Nine types of standard buildings are constructed, several of which are particularly adapted to foundry use. In addition to the illustrations of various types of buildings constructed, cross-sections of these types also are included, as well as dimensions and brief specifications. A list of clients who have had buildings built by this method also is included and among these are many iron, steel and brass foundry companies.

COAL AND ASH HANDLING.—The questions of economical coal and ash handling and the storage of reserve coal supply are treated at length in a 52-page booklet prepared by the Link Belt Co., Chicago. Cost figures offer a comparison between hand wheeling, shoveling and firing with the modern handling through conveying, bin and firing machinery. Detailed descriptions with a number of drawings and illustrations serve to explain the mechanical features of belt carriers, storage and conveying systems, and weighing and measuring devices for coal. Typical installations in large industrial establishments are noted. These point out the means by which economies have been effected in actual practice by machine handling and by well planned storage.

FUEL OIL ENGINE.—A bulletin, containing 32 pages, issued by the Chicago Pneumatic Tool Co., Chicago, is devoted to semi-diesel fuel oil engines, which operate on any petroleum distillate that does not contain more than 1 per cent sulphur and from 28 to 40 degrees Beaume scale. The engine is of the horizontal, straight line, crosshead type and in the larger sizes it is mounted on a substantial base, so designed that when the machine is in operation it is free from vibration. The bulletin illustrates and describes the various parts of this machine and gives dimensions of sizes and capacities.

STEEL WINDOWS.—The Detroit Steel Products Co., Detroit, has published a 41-page illustrated catalog showing the construction and installation of steel sash windows. Valuable information on the removal of heat and gases from foundries or shops of the so-called hot building type is contained in this work. Detailed drawings of the different forms of sash explain fully the different construction principles, while photographic illustrations depict the windows in service. Both hand and electrically-controlled operating devices are used with these windows.

ALLOY METALS.—The Ajax Metal Co., Philadelphia, has prepared a booklet of general information regarding its ingot metals. This is a companion edition to "A Text Book on Babbitt Metals", and deals with the standard alloys which are manufactured by this company. Suggestions are offered regarding the surface indications which mark good ingots, and the proper use of the metals in practice is described. Bearing-testing machine tests of a series of copper-tin, copper-tin-lead and copper-tin-lead-zinc alloys are tabulated for easy reference and the standard specifications for different bronze and brass ingots manufactured by the company are outlined at length.